ELECTRICITY IN CROP CONDITIONING

REA

U. S. DEPARTMENT OF AGRICULTURE RURAL ELECTRIFICATION ADMINISTRATION

INTRODUCTION

Electricity on farms makes practical artificial conditioning or curing of many crops. It provides low-cost power for the job and makes possible the use of the various automatic and remote controls that are needed.

The use of electricity in crop conditioning is especially significant in the present National emergency. It can reduce crop waste, reduce the need for farm labor and assure products that can be safely and efficiently stored, transported, processed and consumed.

Although the use of electricity for conditioning farm crops has increased year by year for many years, the recommendations of authorities on design, construction specifications, operating methods, and other important factors vary widely. This is partly due to differences in climatic conditions, farming practices, crop varieties and other variations throughout the country.

This publication, prepared by the Technical Standards Division of REA, summarizes the latest recommendations on crop conditioning by the various State Agricultural Colleges, the U. S. Department of Agriculture, and other recognized sources of authentic information. It should serve as a guide to electric cooperatives, public power districts and others engaged in helping farmers to use electricity more effectively on the farm.

The report is divided into seven parts as follows:

1. Moisture Requirements
2. Air Requirements
3. Heat Requirements
4. Structure Requirements
5. Operating Instructions
6. Feeding and Grading Evaluations
7. References

Crops are listed alphabetically within each section and the information for each crop is summarized alphabetically by States. Only those references are included which contain the latest recommendations.

REA appreciates the assistance given by the personnel of the institutions identified with the contents of the report in providing the basic research data and reviewing the abstracts.

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ELECTRO-AGRICULTURE SECTION
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MOISTURE REQUIREMENTS

Barley

North Carolina

Barley contained 20 percent moisture before drying and 15 percent after, using the drier designed by the college. Moisture is on wet basis.

Beans

Washington

In college tests the initial moisture content of beans was 31 to 40 percent and the final moisture content was 14 to 18 percent. Moisture determinations are on an oven dry basis. With a final moisture content of 18 percent the beans were not considered safe for storage and the test was stopped before the beans were sufficiently dried.

Broomcorn

Texas

Initial moisture content of broomcorn varied from 35 to 65 percent in tests during the past three years. Final moisture content of 15 percent is satisfactory for baling.

Corn

Georgia

For seed corn the safe practice is to reduce the moisture content at the time of drying to at least 12 percent.

Illinois

For ear corn and shelled corn see USDA recommendations.

Indiana

Ear corn picking can start when the corn kernel averages 30 percent or less moisture. Corn should be dried to an average of 12 percent. This can be determined when the wettest layer, where air leaves the corn, is about 18 percent moisture. For shelled corn see USDA recommendations.

Iowa

In college tests the moisture content of ear corn was reduced from 31.1 percent to 19.8 percent. For ear corn and shelled corn see USDA recommendations.

Kentucky

Ear corn should not contain more than 20.5 percent moisture when stored unless mechanical drying is provided. Try to allow maximum drying in the field and harvest the driest corn first. For cribs wider than 10 ft. reduce the safe moisture content (20.5 percent) by one percent for each additional foot of width.

MOISTURE CONTENT (PERCENT) AND VENTILATION NECESSARY FOR EAR CORN

Percent Moisture	Ventilation Recommendations
20 or less	May be stored in cribs without ventilation.
20 to 25	Use ventilators. Forced air is safer.
25 to 30	Use forced air circulation.
30 or above	Leave in field or use heated forced air.

Michigan

For ear corn and shelled corn see USDA recommendations.

Nebraska

Ear corn with kernel moisture up to 25 percent can be dried and stored in cribs properly designed and with suitable ventilators. When the moisture content is over 25 percent some other means must be employed. The upper moisture limit at which ear corn can be dried economically either with heated or unheated air has not been established. Maximum moisture for safe storage is 18 to 20 percent. Shelled corn can be dried successfully with either heated or unheated air at any moisture content. Maximum moisture for safe storage is 12 to 13 percent. Final drying of shelled corn and other grains must be done with humidity below 50 percent.

North Carolina

For ear corn the initial moisture content was 25 to 30 percent and the final moisture was 14 percent (wet basis) using drier designed by the college. For seed corn initial moisture was 25 to 35 percent and final 14 percent or less using seed corn drier designed by the college. For shelled corn the initial moisture was 20 percent and the final moisture 14 percent (wet basis) using drier designed by the college.

Ohio

Ear corn containing less than 14 percent moisture is safe to store in tight bins. Corn usually will not dry to below 18 percent with natural

Ohio (Cont)

air during the cool weather of autumn and winter. It is safe during the cool season but may go out of condition during the warm spring weather. Corn of high moisture content, 35 to 45 percent or higher must have special means of drying and cooling in crib or bin storage. Seed corn should be reduced to 14 percent moisture or lower and held there throughout the storage period. Shelled corn should be dried to less than 14 percent moisture. If it is to be ground for feed the moisture content should be around 9 or 10 percent.

Oregon

Moisture content of ear corn at harvest time will range from 25 to 30 percent and occasionally 35 percent. In tests performed by the college the moisture content before and after drying was determined to be 27.8 and 9.7 percent respectively. The relative humidity of the discharged air should be kept at 65 percent. Shelled corn should be dried so that the moisture content does not exceed 15 percent. The relative humidity of the discharge air should be kept at 70 percent.

Texas

In tests at the college ear corn was dried from 15.5 percent moisture to 12.8 percent.

U. S. Department of Agriculture

Ear corn containing 20 to 25 percent moisture in the kernels may be severely damaged if harvested and cribbed without special precautions. Corn having 25 to 30 percent is very likely to spoil in cribs and that having over 30 percent is likely to spoil in the crib if held longer than through the cold winter months. If it is to be stored longer, then drying with heated air or forced ventilation may be investigated. If moisture content is above 30 percent and if harvest is followed by long periods of humid weather some risk of spoilage may be taken if unheated air is used. Corn can be stored safely in a crib for a full year if dried to 18 to 20 percent in fall or winter. Shelled corn must be dried to 12 or 13 percent moisture to be safe for summer storage. Other moisture requirements are similar to those for ear corn. A large part of the cob moisture is avoided if corn is shelled before drying. See USDA references, Nos. 1, 2, 3, 4, 5, 8, 9, 11, 12.

Cottonseed

Texas

Only cottonseed with a low free fatty acid content and with a moisture content of less than 12 percent should be stored.

Cowpeas

Texas

In tests with cowpeas at the college the moisture content was reduced about six percent in 6.5 hours.

Flax

Texas

For flax, tests indicate that 7 to 8 percent is the maximum moisture content for safe storage.

Grain Sorghum

Nebraska

The maximum moisture content of grain sorghum for safe storage is 13 percent.

North Carolina

For grain sorghum the initial moisture content was 20 percent and the final was 14 percent (wet basis) using drier designed by the college.

Texas

For grain sorghum a final moisture content of about 11 percent is satisfactory in the Gulf Coast area. In the Plains area the moisture content should not exceed 13 percent.

U. S. Department of Agriculture

The median moisture limit of grain sorghum for storage for one year or longer without loss in market grade is 13 percent. In a cold location this may be one to two percent higher and in a warm location one or two percent lower. If the moisture content is uneven the wettest grain should not be above these limits. See USDA references Nos. 2, 3, 6, 8.

Grain

Tennessee Valley Authority

Combined grain, stored in ordinary bins at moisture contents of 16 to 18 percent must be spread and turned at frequent intervals if mold is to be prevented.

Hay

California

Hay usually will need to field cure for one or two days, as most green forage crops contain 75 percent moisture or more when cut. Long hay should have less than 50 percent moisture when placed on drier. Chopped or baled hay should have less than 35 percent moisture when placed on drier.

Connecticut

It is recommended that early cut hays and heavy legumes be ensiled due to early season weather hazards. Most desirable moisture content is 35 to 45 percent when placed in drier. Young forages require at least three days for field drying and in this region there seldom are three consecutive days of good drying weather at any time. For mow drying, at least one day of good drying weather is required.

Illinois

For alfalfa hay it is generally assumed that 40 percent is the optimum initial moisture content. In tests the reduction from 40 to 13 percent moisture content using 15.8 kwh per ton of dry hay is regarded as typical for alfalfa. For mow curing without heat long hay should be field cured to a maximum of 45 percent moisture. Chopped hay should be field cured to 35 percent moisture. Long soybean hay should be field cured to 35 percent moisture.

Indiana

Hay should be placed in the mow at about 35 percent moisture. Leaves begin to shatter at about 33 percent. Small quantities having as high as 50 percent moisture have been dried successfully. Final moisture content of 15 percent.

Kentucky

Recommends placing hay in drier just before it is dry enough for the leaves to shatter when handled in the field. At this point the hay will contain a little over 33 percent moisture. Hay of higher moisture content should not be placed in the drier unless the crop is to be saved by doing so.

Maine

It is recommended that early cut hays and heavy legumes be ensiled due to early season weather hazards. In mow drying all hay should be field dried to a moisture content of 40 percent. Do not cut more hay than can be properly handled.

Michigan

For long or chopped hay the moisture content should be below 35 percent when placed in the drier. A few loads of high moisture hay (45 to 50 percent) can be stored provided that it is well distributed and that the average moisture content of all hay dried during the season is not more than 35 percent. Dry hay has an average moisture content of about 12.5 percent. No tight pressed baled hay should contain more than 25 percent moisture. If loosely baled the moisture content may be as high as 30 percent.

New Hampshire

It is recommended that early cut hays and heavy legumes be ensiled due to early season weather hazards. In mow drying all hay should be field dried to a moisture content of 40 percent. Do not cut more hay than can be properly handled.

North Carolina

For loose hay the initial moisture content was 45 percent and the final 20 percent when using drier designed by college. For chopped hay the initial moisture content was 45 percent and the final 20 percent when using drier designed by college. For baled hay the initial moisture content was 35 percent and the final 15 to 18 percent when using drier designed by college. All moisture contents were on a wet basis.

Ohio

Chopped hay should not contain over 35 percent moisture. Leaf shattering of long hay occurs at moisture content below 30 percent and 30 to 45 percent is the desirable range. Hay should be dried to as low as 20 percent moisture in order to be safe from excessive heating or mold damage in storage. Such damage may result in hay containing over 25 percent moisture.

Oregon

If hay is chopped long and contains 25 to 30 percent moisture it can be cured by natural draft except in the coastal region during foggy weather. Hay up to 40 percent moisture if chopped long can be cured by forced draft cold air. Hay up to 50 percent moisture if chopped long can be cured using heated air.

Pennsylvania

Field cure hay until moisture content is 40 to 45 percent.

Tennessee Valley Authority

Optimum moisture content for drying hay is between 40 to 50 percent. If rain damage is likely to occur hay with moisture content higher than 50 percent may be placed in the drier. Hay with as high as 75 percent moisture has been successfully dried but this is not recommended.

Texas

In tests with long alfalfa hay the initial moisture content varied from 65 to 40 percent and the final moisture from 20 to 24 percent. Hay must be reduced to a moisture content of 20 percent before it can be stored safely. For chopped hay, tests were made with a portable rotary drum dehydrator and with a four wheel farm type trailer. Hay should be placed in the drier before the leaves begin to shatter. At this point the moisture content varies from 40 to 45 percent. In college tests baled hay tested about 36 percent moisture. Hay should be baled when the moisture content is above 40 percent to prevent excessive loss of leaves.

U. S. Department of Agriculture

Alfalfa hay should be cut at the 1/10 to 1/4 bloom stage. The time to dry in the field depends upon the crop and the method of harvesting and drying. The hay should be placed in the mow just before it is dry enough for the leaves to be lost by shattering when handled. The use of supplemental heat permits placing forage on driers at higher moisture contents. See USDA reference No. 10.

Vermont

It is recommended that early cut hays and heavy legumes be ensiled due to early season weather hazards. In mow drying all hay should be field dried to a moisture content of 40 percent. Do not cut more hay than can be properly handled.

Virginia

When first cut, alfalfa hay will average 65 to 75 percent moisture. On a clear day four to six hours field drying will reduce the moisture to about 45 percent, at which moisture content it is ready for barn drying. Hay at 20 percent moisture or below is safe for storage. Alfalfa should be cut when it is between one-tenth and one-quarter full-bloom stage. The trend is toward earlier cutting.

Washington

For beet top hay the final moisture content in college tests was 16 percent. In college tests it was found that pea vines must be dried in less than five days to prevent mold growth. The moisture content of the dried vines must be about 15 percent to insure safe storage.

Wisconsin

Hay should be field dried to about 30 to 35 percent moisture. Field dried alfalfa hay can be stored safely at 25 to 28 percent moisture. Long cut chopped hay can be safely stored at 25 percent moisture.

Oats

North Carolina

For oats, the initial moisture content was 18 percent and the final 15 percent (wet basis) using drier designed by the college.

U. S. Department of Agriculture

See "Grain Sorghum", also USDA references Nos. 2, 3, 6, 8 .

Peanuts

Alabama

For peanuts the moisture content requirement for safe storage is not known.

Georgia

Freshly dug peanuts contain from 30 to 48 percent moisture (wet basis). This must be reduced to at least 9.5 percent in the kernel in order to be sold under support price, a buying regulation in effect in 1949. Results indicate that the minimum moisture content in curing is a factor in the resultant shelling damage. Specific requirements are not known as yet.

North Carolina

Peanuts for oil stock had an initial moisture content of 35 percent and a final of 10 percent (wet basis) using drier designed by the college. Peanuts can be dried from the "green" state (45 percent moisture) without apparent damage. If moisture is above 20 percent, high temperatures must be avoided. Peanuts with 30 percent or more moisture, if left in bulk storage without ventilation for 12 hours or more, are sure to heat and be seriously damaged.

South Carolina

Use recommendations of North Carolina.

Texas

The moisture content of peanuts must be about seven percent to be sold on the market. Field or shed drying may require six to eight weeks, depending on the weather. In tests the moisture content initially ranged from 10 to 27 percent (wet basis).

Potatoes

North Carolina

For sweet potatoes, recommend a curing and holding process where starches are converted to sugars with as little loss of moisture as possible.

South Carolina

For sweet potatoes, humidity should be maintained between 80 and 85 percent at all times. A vapor barrier on the inside of the house is desirable and would improve the insulating value. In college tests high humidity was obtained by wetting the clay floor of the house. An average of three to four applications of water were necessary. Excessive humidity may cause condensation on the potatoes and produce conditions favorable to storage rot.

U. S. Department of Agriculture

For storage of white potatoes, the following is recommended: Wound healing period - 90 percent relative humidity. Holding period - 90 percent humidity. See USDA reference No. 7.

Rice

Arkansas

In experimental driers combined rice was dried to 14 percent moisture content. The tempering period of 12 to 36 hours between dryings is important. It gives the moisture in the grain an opportunity to equalize, and thereby reduces the drying time. Combined rice usually contains from 16 to 26 percent moisture when harvested. Some millers say rice should not have more than 13 percent moisture to be safe for bulk storage in hot humid weather. However, 14 percent is widely accepted by the rice industry.

California

Rice should be harvested between 20 and 27 percent moisture. Rice below 20 percent moisture may be sun-checked and of low quality. Alternate

California (Cont)

wetting and drying in field results in severe sun-checking when moisture content is 17 percent or less. For safe bulk storage rice should be dried to 14 percent moisture. Storage in sacks is safe at 15 percent moisture.

Texas

In college tests rice was dried from an initial moisture content of 17 to 24 percent to a final content of 9.8 to 16.4 percent. Various moisture contents have different drying requirements.

Seeds

Georgia

Blue lupine seed may be as high as 30 to 35 percent moisture (wet basis) at the beginning of the harvest period when a portion of the seeds are not quite mature or when the season is unusually rainy. Generally the initial moisture can be expected to run from 16 to 22 percent. The seed should be dried to 11 percent or less (wet basis) immediately after harvesting to prevent deterioration of viability. Depth of seed should be limited to three feet to avoid excessive static pressure. A depth of one foot is desirable from the standpoint of uniform moisture content unless reverse air flow is used.

Tennessee Valley Authority

A sample of crimson clover seed, after drying, had a moisture content of 11.1 percent.

Texas

In tests at the college the initial moisture content of Dallis grass seed averaged 20.5 percent and the final 12.2 percent. The initial moisture content of Rescue grass seed was 52 percent and the final moisture content of about 12 percent and was stored without spoilage.

Soybeans

North Carolina

For soybeans the initial moisture content was 20 percent and the final was 13 percent (wet basis), using drier designed by the college.

U. S. Department of Agriculture

See "Grain Sorghum", also USDA references Nos. 2, 3, 6, 8.

Sugar Beets

Colorado

Much of the sugar loss in sugar beets is due to respiration of the beet and this increases at higher temperatures. In areas of low humidity it seems that adding water to the ventilating air would reduce weight shrinkage. This would best fit into a permanent installation.

Michigan

For sugar beets the optimum relative humidity of the air to be forced into storage piles is about 80 percent. It is not wise to force-ventilate a beet pile while it is raining, except in a critical case. Free water should not be permitted in the air ducts.

Tobacco

North Carolina

For bright tobacco the following humidities are recommended:

Stage of Curing	Critical Relative Humidities (Percent)
Yellowing	92 to 85
Color setting	75, 65, and 50
Drying	25 to 30
Killing	Below 10

South Carolina

Use recommendations of North Carolina.

Wheat

Nebraska

Wheat damage known as "sick wheat" may occur if the moisture content is above 12 percent. This occurs following the dormant period (30 to 45 days) when moisture and temperature conditions are right. Wheat should be dried as soon after harvest as possible or before end of the dormant period. Attempts to dry wheat by shifting with portable elevators or shoveling are not recommmended. Maximum moisture for safe storage is 12 percent.

North Carolina

In drying wheat the initial moisture content was 20 percent and the final was 15 percent (wet basis), using drier designed by the college.

U. S. Department of Agriculture

See "Grain Sorghum", also USDA references Nos. 2, 3, 6, 8.

AIR REQUIREMENTS

Barley

Nebraska

See "Grain".

North Carolina

For barley the minimum air needed is four cfm per cu. ft. of grain. A static pressure of one inch of water is required to force the air through the slatted or perforated floor with a grain depth of four feet.

U. S. Department of Agriculture

No rigid requirements can be stated for barley as to air flow and depth of grain to be dried in a batch. With unheated air an air flow of three cfm per bu. at a depth of three to six feet generally would be satisfactory. Five cfm per bu. at a depth of three or four feet would be better for very damp grain. Heating grain can be cooled to almost atmospheric temperature by about six hours of ventilation with an air flow of three cfm per bu. With heated air an air pressure of 1.6 in. of water will force 10 cfm per bu. through a depth of 38 in. There is no definite upper limit for pressure or depth, provided a suitable blower is used. However, a pressure over two or three inches may make power requirement excessive. Most farm drying units do not develop pressure of more than two inches of water. See USDA references Nos. 2, 3, 6.

Beans

Washington

In college tests with beans, the average air flow ranged from 65 to 67 cfm per sq. ft. and the static pressure ranged from 0.53 to 0.54 in. of water.

Broomcorn

Texas

For broomcorn recommend a minimum of 40 cfm per sq. ft. of floor area.

Corn

Georgia

The air flow recommended for feed corn is between 5 and 10 cfm per bu. of ear corn. A rate of 15 to 20 cfm per bu. is advantegeous in drying

Georgia (Cont)

seed corn, particularly when the air flow is in one direction only, as the higher rate results in more uniform moisture content and decreases the time required for drying. Reversing the direction of air flow results in a much more uniform moisture content. For each 1000 cfm of air provide a minimum of one square foot of duct area.

FAN CAPACITIES AND SIZES FOR TYPICAL EAR CORN DRYING INSTALLATIONS

Amount of Corn (Bu.)	Depth of Corn (Ft.)	Minimum Air Volume (Cfm)	Static Pressure (In. of Water)	Fan Types and Sizes Propeller (In.)	Fan Types and Sizes Centrifugal (In.)	Electric Motor (Hp.)
500	8	5,000	$\frac{1}{2}$ minus	21	18	$1\frac{1}{2}$
500	16*	5,000	1 minus	24	20	$1\frac{1}{2}$
1000	12	10,000	$\frac{1}{2}$	27	24	3

* Using two bins each eight feet deep; air flows up through one and down through the other.

Illinois

For ear corn and shelled corn see USDA recommendations.

Indiana

For corn, if heat is used an airflow of 5 to 10 cfm per bu. has proved satisfactory. With unheated air 10 to 15 cfm per bu. is needed. It is usually best to have a fan and motor for each crib in case additional fan operation is needed in the spring. For shelled corn see USDA recommendations.

Iowa

For ear corn and shelled corn see USDA recommendations.

Kentucky

For drying ear corn blowers from threshing machines and ensilage cutters are not recommended. Recommend a fan capable of 5 to 10 cfm per bu. of corn. For a 300 bu. crib, the fan should deliver 1,500 to 3,000 cfm against a static head of 0.5 in. of water. Air should pass through as nearly as possible the same thickness of corn in all directions. Curing corn with a fan is practical for producers of 300 bu. or more, particularly when a soft corn season occurs and it is desired to carry corn over the winter.

Michigan

For ear and shelled corn see USDA recommendations.

Nebraska

For drying ear corn and shelled corn propeller type fans are the most desirable. Centrifugal type fans can be used if operating conditions are carefully controlled. Of the centrifugal fans the backward curved type is most satisfactory. An air flow of 5 to 10 cfm per bu. of corn is recommended. Faster drying will be attained at 10 cfm. The fan should be operated continuously only when the weather is favorable for drying. In general outdoor temperature should be above 50 degrees F. and relative humidity below 65 percent. It may be necessary to operate the fan during prolonged storage in case the moisture content should rise above safe limits in certain areas. See "Grain".

APPROXIMATE STATIC PRESSURE FOR AIR FLOW OF 10 CFM THROUGH EAR CORN

Depth or Thickness of Corn (Ft.)	Static Pressure (In. of Water)
6	0.3
8	0.6
10	1.1 (Estimated)
12	1.7 (Estimated)

STATIC PRESSURES FOR AIR FLOWS OF 6 AND 10 CFM THROUGH SHELLED CORN

Depth of Corn (Ft.)	Pressure for Delivering 6 Cfm (In. of Water)	Pressure for Delivering 10 Cfm (In. of Water)
4	0.68	1.6
6	1.9	4.1
8	4.0	9.0

North Carolina

For ear corn the minimum air needed is 4.5 cfm per cu. ft. of corn. A static pressure of 0.5 in. of water is required to force air through slatted or perforated floor with a corn depth of six feet. For seed corn recommend four cfm per cu. ft. of corn and a static pressure of 0.75 to 1 in. of water is required to force air through a depth of eight feet. For shelled corn the minimum air needed is four cfm per cu. ft. of corn. A static pressure or 0.5 in. of water is required to force air through a depth of four feet.

Ohio

For ear corn provide about five cfm per cu. ft. of corn. To force this amount of air through 10 feet of corn requires a static pressure of about 0.5 in. of water. The amount of air needed varies with the temperature and relative himidity of the air and the moisture content of the corn. Recirculation of air should be avoided and safe practice is to use more fresh air even if it means a lower temperature of the drying air. Either

Ohio (Cont)

propeller or multivane type fans may be used. The forward curved blade multivane fan must have a motor large enough to handle any overload which may be imposed upon it. Power requirements should be studied carefully before making a decision. Overload switches should be provided especially with the forward curved multivane fan. Separate rather than direct connected motors are desirable. V-belts are recommended. Each V-belt will transmit about two horsepower. Where power is high in cost it may be more desirable to use a large fan because it should reduce the amount of power used.

CUBIC FEET OF AIR PER MINUTE REQUIRED FOR VARIOUS CAPACITIES OF AN EAR CORN DRYING PLANT, ASSUMING A 15-DEGREE TEMPERATURE DROP

Rate of Drying Ear Corn in Bushels (35 Percent Moisture at Start)			Volume of Air Needed in Cubic Feet per Minute
Per hour	Per day	Per 20-day season	
1	24	480	2,400
2	48	960	4,800
3	72	1,440	7,200
5	120	2,400	12,000
10	240	4,800	24,000

In university tests with shelled corn one to three cfm per bu. gave good results with the higher amount being more desirable. It required about one-inch static pressure to force two cfm of air per cu. ft. of corn having a maximum depth of seven feet. Small multivane fans or any type that will deliver air against 0.5 or 0.75 in. of water should be suitable for bins up to 200 or 300 bu. in size. Air velocity should not be greater than 1,000 fpm.

Oregon

For ear corn recommend 50 cfm per sq. ft. of kiln floor. An air velocity of 50 to 75 fpm through the kiln produces satisfactory results. Multiblade axial flow fans are satisfactory. The static pressure need not exceed 0.2 in. of water. (See HEAT REQUIREMENTS). Drier used at college is designed so that 50 to 80 percent of the air can be recirculated to the heating plant. For shelled corn a minimum of 100 cfm per sq. ft. of column area is desirable. Two-blade propeller and multiblade windmill fans are adaptable where operating against a low static pressure. A multivane fan is recommended for operation of shelled corn driers.

Texas

Ear corn needs a minimum of 30 cfm per sq. ft. of floor area. Recommend 40 to 50 cfm per sq. ft. Static pressure should be about one inch of water when corn is four feet deep on drier.

U. S. Department of Agriculture

In drying ear corn with unheated air recommend 5 to 10 cfm per bu. For heated air and drying 300 to 1500 bu. at one time recommend 9,000 cfm delivered to crib against a static pressure of 0.5 in. of water, this pressure to be in addition to the pressure drop through the drier. For a portable heated air drier the fan motor should not exceed three brake horsepower and should be single phase, 60 cycle, 220 volt repulsion start, induction run or capacitor with magnetic starter and thermal overload cut-off switch. It should be connected by a V-belt drive. The power required to force air through shelled corn stored in a bin is much greater than for ear corn. The resistance to air flow depends greatly on the depth.

PRESSURE IN INCHES OF WATER REQUIRED TO FORCE AIR THROUGH SHELLED CORN

Depth of Corn (Ft.)	For 4 cfm per Bushel		For 10 cfm per Bushel	
	Pressure required (In.)	Power required per 1000 bu. (Hp.)	Pressure required (In.)	Power Required per 1000 bu. (Hp.)
2	0.045	3/4	0.20	2
4	0.40	1	1.6	4
8	2.3	3	9.0	27

The other requirements for air are the same as for ear corn. See USDA references Nos. 1, 2, 3, 4, 5, 6, 8, 9, 11, 12.

Wisconsin

For ear corn recommend an air flow of 40 cfm per sq. ft. of floor area at one inch static pressure.

Cottonseed

Texas

Aeration of cottonseed should be confined to low volumes of 4 to 10 cfm per sq. ft. of floor area. The large decrease in volume and the small difference between the resistance of linted and delinted seed to air flow at volumes below 10 cfm per sq. ft. of floor area, indicate that delinting would be a profitable operation.

Cowpeas

Texas

Cowpeas require minimum of 30 cfm per sq. ft. of floor area. Recommend 40 to 50 cfm per sq. ft.

Flax

Texas

The most efficient results for drying flax seed to 7 to 8 percent moisture in a column type drier was with an air velocity of 70 to 80 fpm through the grain column. Static pressure varied from 3.2 to 3.8 inches of water with a column 10 in. wide.

Grain Sorghum

Nebraska

See "Grain".

North Carolina

For grain sorghum use 2000 cfm in the tobacco barn crop drier designed by the college. A static pressure of one inch of water is required to force air through slatted or perforated floor with a grain depth of four feet.

Texas

For grain sorghum the most efficient results for drying to 12 percent moisture was with an air velocity of 80 to 90 fpm through the grain column. Recommend 90 to 100 cfm per sq. ft. of column area in column type drier with a static pressure of from 2.0 to 2.5 in. of water. In college tests the batch type column drier contained a centrifugal, single inlet, single width blower, having forward curved blades and 24 in. diameter wheel. This was driven by a five horsepower motor.

U. S. Department of Agriculture

See "Barley", also USDA references Nos. 2, 3, 6, 8.

Grain

Alabama

For grain use four cfm per bu.

Nebraska

For wheat use same recommendations as for ear corn.

Nebraska (Cont)

STATIC PRESSURES REQUIRED TO FORCE AIR THROUGH CLEAN GRAIN AT VARIOUS DEPTHS

Grain	4 Ft.	6 Ft.	8 Ft.	10 Ft.
Barley	0.15	0.35	0.65*	1.0*
Corn (Shelled)	0.055	0.18	0.4	0.8*
Oats	0.19	0.45	0.85	1.4*
Sorghum	0.2	0.47	0.9*	1.5*
Wheat	0.42	1.0	1.5*	2.5*

* These figures are approximations made by extrapolation beyond available data. Chart is based on air flow of one cfm per sq. ft. for each foot of depth.

Hay

Alabama

For hay recommend 15 cfm per sq. ft. of mow area.

California

For long hay recommend 16 cfm per sq. ft. of mow area at a static pressure of 0.75 in. of water. For chopped hay recommend 20 cfm per sq. ft. of mow area at a static pressure of 1 to 1.25 in. of water. For baled hay recommend 25 cfm per sq. ft. of mow area at a static pressure of 1.25 to 1.5 in. of water. Air velocity should be limited to 1,000 fpm. The vaneaxial fan is probably the best all-around fan for hay drying but it is high in first cost. However, the centrifugal types, forward or backward curved blades, and the propeller type are suitable. The high speed propeller fan is widely used because it is inexpensive, light weight, usually nonoverloading and easy to install. Motor should be connected through a magnetic starting switch for protection.

FANS FOR HAY DRIERS

Fan	Price	Noise	Efficiency	Installation
Backward - curved centrifugal	High	Little	High	For greatest capacity must be equipped for changes in speed.
Forward - curved centrifugal	Medium	Little	Fair	When static pressure is low it will overload motor unless air flow is dampered or fan speed changed.
Propeller	Low	Much	Good	Simple.
Vaneaxial	High	Medium	High	Simple.

Connecticut

For long hay recommend 15 cfm per sq. ft. of mow area. Baled or chopped hay, 20 cfm per sq. ft. of mow area. Plenum chamber velocity, 1,000 fpm or less. Drier should be designed for static pressures of 0.75 to 1 in. Propeller type fan is best but centrifugal can be used. Motor should have a frame that gives protection from dust and chaff. Use manual control with thermal overload protection.

Illinois

For alfalfa and soybean hay recommend a minimum of 15 cfm per sq. ft. of mow area.

Indiana

According to a rule of thumb fans or blowers should handle about 10 tons of hay per cutting for each horsepower of power unit, i.e. a five horsepower fan should handle 50 tons of hay over a week to 10-day period. A five horsepower fan should deliver 16,000 or more cfm at one inch static pressure and 7.5 horsepower should deliver 21,000 or more cfm at on inch pressure. The six bladed propeller, tubeaxial, or backward curve centrifugal fans are satisfactory. Ordinary ventilating fans will not do the job. Air velocity in the main duct should be kept below 1,000 fpm.

Iowa

For hay an air flow of 10 cfm per sq. ft. of mow area will in most cases require motors of three horsepower or larger. Higher air flows may cause the motor requirements to be larger than can be handled by transformers on most farms.

Maine

For hay the system should deliver at least 20 cfm per sq. ft. of mow area at a static pressure of 0.75 to 1 in. The most common type of fan used is the propeller type although the centrifugal type can be used. The motor should have a frame that gives protection from dust and chaff. Use manual control with thermal overload protection. The average air velocity in the main duct should be about 1,000 fpm.

FAN AREAS - PROPELLER TYPE

Diameter (In.)	Area (Sq. Ft.)
30	4.9
32	5.5
36	7.1
42	9.6
44	10.6
48	12.6
54	15.9
60	19.6

Michigan

For hay usually a minimum of 15 cfm of air is needed per sq. ft. of floor area. Air velocity should not exceed 1,000 fpm in any part of the tunnel. The propeller type fan or the centrifugal blower type with backward curved blades is suitable for hay drying. The centrifugal blower type with blades that curve forward is not well suited for use with electric motors for drying hay in the barn. For long barns the use of two fans, one on each end, reduces the size of main tunnel needed and provides greater flexibility of operation. Motors should have protection against overload and low voltage. Magnetic switch with thermal protection is recommended.

New Hampshire

For hay the system should deliver at least 20 cfm per sq. ft. of mow area at a static pressure of 0.75 to 1 in. The most common type of fan used is the propeller type although the centrifugal type can be used. The motor should have a frame that gives protection from dust and chaff. Use manual control with thermal overload protection. The average air velocity in the main duct should be about 1,000 fpm.

North Carolina

For loose hay the minimum air needed is two cfm per cu. ft. of crop. A static pressure of 0.5 in. of water is required to force air through slatted or perforated floor with a crop depthof 10 ft. For chopped hay the minimum air needed is 2.5 cfm per cu. ft. of crop. A static pressure of 0.55 in. of water is required to force air through slatted or perforated floor with a crop depth of eight feet. For baled hay the minimum air needed is four cfm per cu. ft. of crop. A static pressure of 0.5 inches of water is required to force air through a depth of six feet.

Ohio

Propeller or multivane fans may be used for drying hay. Of the multivane type the backward curved blade fan is most desirable. Belt driven units are preferable. Safety or overload switches should be provided. For baled hay use about 30 cfm per sq. ft. of floor area covered with about 4 tiers of hay. The fan should be capable of operating against about 0.75 to 1.25 in. static pressure in the main tunnel. This is for a moisture content under 35 percent. For long hay the forward curved multivane fan, although efficient presents a problem of power requirement in a situation where the resistance varies. The lower the resistance, the greater the power requirement. If hay is 10 feet deep and contains 35 percent moisture at least 15 cfm per sq. ft. of floor area should be provided. If it has 45 percent moisture then it should be either stacked half as deep (5 feet) or the air rate of flow should be doubled. For chopped hay from 15 to 20 cfm per sq. ft. of floor area is about the maximum at one inch static pressure.

Oregon

For hay recommend 15 to 20 cfm per sq. ft. of drier floor area with a static pressure of 0.75 to 1 inch of water and a main duct air velocity of 1,000 fpm. Lateral duct or slatted floor should have a velocity of 800 fpm. Supply air to fan from outside of barn. Either a propeller or forward curve multivane fan may be used. With the multivane type overloading of the motor can be prevented by throttling the intake to the fan.

Pennsylvania

For hay recommend 25 cfm per sq. ft. of mow floor at 0.5 in. static pressure and 20 cfm per sq. ft. of mow floor at one inch static pressure.

Tennessee Valley Authority

For hay use a minimum of 15 cfm per sq. ft. of mow floor area. More air is desirable. Design the main duct to obtain an air velocity of not more than 1600 fpm. With 15 to 16 ft. of hay a static pressure of not less than one inch of water may be used in selecting the fan. For six to eight feet of hay a static pressure of 0.5 to 0.6 inches may be used. Fans which will deliver a constant volume of air against a varying static pressure at a given speed are desirable. None of the fans used in farm drying will do this. Some are better than others but will not achieve this purpose. They should have a relatively low first cost. Propeller type fans with curved blades either of wide area or air foil shape are suitable for hay-driers. The centrifugal type fan with forward curved blades may be used but presents a problem of overloading the motor where resistance to air flow varies widely. This can be overcome by:

a. Providing a means of varying fan speed. May be done by two different sets of pulleys or use a combination A and B-section pulley and two sets of belts. An adjustable pulley on motor is also satisfactory.

b. Providing an adjustable damper in the fan outlet or in the main duct. Use an ammeter to determine dampering needed.

c. Providing a means of dampering the air intake to the fan. Use an ammeter to determine dampering needed.

Backward curved multiblade fans can also be used and they are quiet and efficient. However, the main disadvantages of this type are its greater weight, larger size and higher cost. It would be desirable to install a magnetic starter and other protective devices, mounted directly on the motor. A short center V-belt drive is the type commonly used for hay-driers. In using V-flat drives a pulley with a straight face is preferable. The most widely used method for automatically controlling drier operation is the time switch. Humidistats and thermostats are not

Tennessee Valley Authority (Cont)

recommended as methods of control. Use a time switch with three pairs of trippers; two pairs for night operation and one pair to start the fan in morning and stop it in the evening.

Texas

Long, baled or shopped alfalfa hay with high moisture, 70 to 80 percent, requires a minimum 40 cfm per sq. ft. but recommend 45 to 50 cfm per sq. ft.; medium moisture, 40 to 65 percent, a minimum of 30 cfm per sq. ft., but recommend 35 to 40 cfm per sq. ft. Static pressures: for long hay, 0.25 to 1.2 in. of water for depths varying from 4 to 10 ft. with an air volume of 20 cfm per sq. ft. of floor area; chopped hay, 1.3 in. of water for a 4 ft. depth and 20 cfm per sq. ft. of floor area; baled hay, 1.4 inches when stacked four bales high and using 50 cfm per sq. ft. of floor area. Exception: chopped hay when dried in a trailer type drier requires 90 cfm per sq. ft. of trailer bed area at a static pressure of 0.68 in. of water. For long or chopped peanut hay use same recommendations as for chopped alfalfa hay.

U. S. Department of Agriculture

In drying hay generally a five horsepower blower will supply a mow area of 1000 to 1600 sq. ft. and a $7\frac{1}{2}$ hp unit 1600 to 2000 sq. ft. Air velocity should not exceed 1000 fpm except where supplemental heat is used. A minimum of 15 cfm per sq. ft. of floor area is required. Greater areas may use larger blowers and ducts or more than one drying unit. The most commonly used blowers are the propeller type, and forward curved blade. The backward curved blade is only used where high pressures are encountered and is sometimes used where great depths are to be dried. See USDA reference No. 10.

Vermont

For hay the system should deliver at least 20 cfm per sq. ft. of mow area at a static pressure of 0.75 to 1 in. of water. The most common type of fan employed is the propeller although the centrifugal can be used. The motor should have a frame that gives protection from dust and chaff. Use manual control with thermal overload protection. The average air velocity in the main duct should be about 1,000 fpm.

Virginia

For alfalfa hay no system should be designed for less than 12 cfm of air per square foot of mow area. Approximately 20 cfm per sq. ft. of mow area is the maximum recommended and it would be desirable not to exceed 18 cfm. The propeller, vaneaxial and backward curved centrifugal fans are desirable for hay drying. The backward curved centrifugal is quite expensive, however, it is desirable for drying chopped hay where depths greater than 12 ft. are cured. Repulsion-induction motors are preferable, however, capacitor motors can be used. A magnetic starter and time switch are recommended. Motor should be able to operate with as much as a 20 percent overload. Recommend a general purpose, single pole, single throw time switch, with

Virginia (Cont)

24 hour dial, electric clock movement for 230 v., 60 cycles, and three pairs of ON and OFF trippers. A short center V-belt drive is most desirable. Pulleys should be selected for speeds between 3,500 and 4,500 rpm. Center distance should not exceed 2.5 to 3 times the sum of the pulley diameters and not less than diameter of larger sheave. Center distance adjustment should be provided. For long hay it is desirable to select a fan capable of delivering 15 cfm of air per sq. ft. of mow floor area against 0.75 in. static pressure for depths up to 12 ft. For chopped hay it is desirable to select a fan to deliver 15 cfm per sq. ft. of mow floor area at 0.75 in. static pressure for depths up to 10 ft. In each case higher pressures are required for greater depths of hay. If chopper is set for a cut of 2.5 in., the average length will be 3.5 to 4 in., requiring pressures approximately the same as for long hay.

Washington

In college tests with beet top hay a static pressure of 0.75 in. of water was required to force 23 cfm of air per sq. ft. of drier area through a depth of 18 in. With pea vines the static pressure ranged from 0.20 to 0.38 inches of water. Depths varied from 15 to 17 in. The pressure type system was the most satisfactory method. The suction system was an efficient method but was not adaptable during damp weather, or for continuous loading of green vines on partly dried vines.

Wisconsin

For hay recommend an air flow of at least 15 cfm per sq. ft. of mow area at a static pressure of 1.25 in. The type of fan is of little importance as long as it delivers sufficient air at the required pressure with the available power. A cheap, rugged ammeter to indicate when motor is fully loaded is desirable, along with overload protection.

Oats

Nebraska

See "Grain".

North Carolina

For oats the minimum air needed is four cfm per cu. ft. of grain. A static pressure of one inch of water is required to force air through slatted or perforated floor with a grain depth of four feet.

U. S. Department of Agriculture

In drying oats with heated air an air pressure of 1.6 in. of water will force 10 cfm per bu. through a depth of 37 inches. See "Barley", also USDA references Nos. 2, 3, 6.

Peanuts

Alabama

Recommend 16 cfm per cu. ft. for peanuts containing 50 percent moisture.

Georgia

Generally peanuts can be dried in 24 to 72 hrs. depending on the initial moisture content, with an air flow of 30 cfm per sq. ft. of bin area, up to a depth of eight feet with sufficient fan capacity. Air flow should be directed from top to bottom and vice versa in order to obtain uniform drying if peanuts are piled to a depth of over three feet. Optimum or maximum conditions have not been determined.

North Carolina

For peanuts for oil stock, the minimum air needed is 12 cfm per cu. ft. of crop. A static pressure of 0.5 in. of water is required to force air through a depth of three feet.

Texas

For peanuts a minimum of 40 cfm per sq. ft. of floor area for sub-floor drier and 300 cfm per ft. of tunnel length for tunnel type drier. Static pressure should be about 0.5 to 0.6 in. of water with sacks not over two deep on the drier.

Potatoes

North Carolina

Sweet potatoes require full or partial recirculation of air with provisions for limited ventilation.

South Carolina

In the college sweet potato curing house bottom vents were provided for each electric heating unit and consisted of two lines of eight-inch tile run from the foundation to the heater. The outside ends of the tile are fitted with doors to regulate the intake of cold air. The top vents for exhausting the air, are located in ceiling and are fitted with doors controlled with ropes.

U. S. Department of Agriculture

It is usually difficult to hold white potatoes until late spring unless automatic ventilation and circulation are used to keep the storage temperature down while the weather is getting warmer. Continuous air circulation is needed. When electricity is available, forced circulation is recommended if close temperature regulation is desired, especially if the storage is some distance from the farmstead. See USDA reference No. 7.

Rice

Arkansas

It is important that stored rice be well ventilated, especially at the top of the bins. In the drying operation the most commonly used static pressure was 1.1 in. of water.

Texas

Rice in sacks requires a minimum of 30 cfm per sq. ft. of floor area. Recommend 40 to 50 cfm per sq. ft.

Rye

U. S. Department of Agriculture

For rye use same recommendations as for "Barley". Air requirements for heated air is not given. See USDA references Nos. 2, 3, 6.

Seeds

Alabama

For a blue lupine seed drier of 375 bu. capacity, plans call for 2,000 cfm at two inches static pressure with a fan having backward curved blades. Other capacities and kinds of seed will require different air flows and static pressures.

Georgia

For blue lupine seed the optimum air flow rates for varying conditions of temperature and moisture have not been determined accurately. A rate of about 20 cfm per **cu.** ft. of seed appears best. Equipment to dehydrate the air with calcium chloride has been tested and an air flow of 34 cfm per cu. ft. of seed proved to be very good. More tests are to be run using this type of equipment.

North Carolina

For lespedeza seed the minimum air needed is four cfm per cu. ft. For seed cotton the minimum air needed is five cfm per cu. ft.

Texas

For Dallis grass seed a minimum of 30 cfm per sq. ft. of floor area is required with a static pressure of 0.75 in. of water at one foot depth. Recommend 40 to 50 cfm. For Rescue grass seed using a bin type drier a minimum of 30 cfm per sq. ft. of floor area is required. Recommend 40 to 50 cfm per sq. ft. Column type drier requires a minimum of 80 cfm per sq. ft. of column area at a static pressure of about 0.5 in. of water. Sudan grass seed in sacks two deep, requires a minimum of 30 cfm per sq. ft. of area covered, with a static pressure of about 0.75 in. of water. Recommend 40 to 50 cfm per sq. ft.

Soybeans

North Carolina

For soybeans the minimum air needed is four cfm per cu. ft. of crop. A static pressure of 0.5 in. of water is required to force air through a depth of four feet.

U. S. Department of Agriculture

For soybeans when using heated air an air pressure of 1.6 in. of water will force 10 cfm per bu. through a depth of 58 inches. It usually will be more economical to dry a depth of not over four to six feet. See "Barley", also USDA references Nos. 2, 3, 6.

Sugar Beets

Colorado

For sugar beets at least 10 cfm of air per ton of beets should be used as a design figure. More than this amount would be a safety factor to insure against special conditions causing rapid temperature rises in the pile. Duct velocity should not exceed 1,000 to 2,000 fpm, preferably nearer 1,000 fpm. In general, a fan which will deliver air at a static pressure of one inch of water is sufficient in a well designed system.

Michigan

Sugar beets should be cooled initially by blowing 20 to 30 cfm of ambient air per ton of beets into the pile until the temperature drops 5 to 10 degrees F below the mean daily temperature. Air at 10 cfm per ton will then be sufficient to maintain the pile.

Tobacco

North Carolina

For **bright leaf tobacco** recommend full or partial recirculation. The air movement resulting from natural draft appears to be ample for tobacco curing.

Wheat

Nebraska

The requirements for wheat are same as for ear corn. See "Grain".

North Carolina

For wheat the minimum air needed is four cfm per cu. ft. of grain. A static pressure of 1.5 in. of water is required to force air through slatted or perforated floors with a grain depth of four feet.

U. S. Department of Agriculture

For wheat where using heated air an air pressure of 1.6 in. of water will force 10 cfm per bu. through a depth of 31 inches. See "Barley", also USDA references Nos. 2, 3, 6.

HEAT REQUIREMENTS

Barley

North Carolina

Recommend an air temperature of 100 to 120 F for barley.

U. S. Department of Agriculture

Drying barley may not be more economical at high than at low temperatures even though the rate of drying is increased. It is recommended that drying air temperatures be kept below 130 F. A limit of 110 F is considered necessary if the grain is to be used for seed. See USDA references Nos. 2, 3, 6.

Beans

Washington

In college tests with beans the air was heated by a 1,500 w. heater controlled by a wafer-type thermostat. The average air temperature in plenum chamber was 67 F.

Broomcorn

Texas

For broomcorn recommend a maximum air temperature of 150 F.

Corn

Georgia

For seed corn the most practical and simplest method for drying is to force heated air through the corn in one direction. Generally 110 F air is considered the maximum temperature. The most practical fueld are fuel oil, butane or propane gas. Practically none of the commercial driers can be classed as firesafe although the risk is not great if the drier is properly installed and operated. Every drier should have at least two automatic controls: one as a high limit control in the drying air stream and the other in case of flame or ignition failure. A spark arrester is desirable if a heat exchanger is not used, and screens and filters should be examined often.

Illinois

For ear corn and shelled corn see USDA recommendations.

Indiana

For drying ear corn in mild weather, air heated 20 to 30 degrees above outside temperature may be desirable.

Indiana (Cont)

Safe Upper Temperature Limits for Drying Corn

Commercial corn	130 F
Seed corn	110 to 120 F

If corn is dried with unheated air, run fan only when air temperature is above 50 F and the relative humidity below 70 percent.

Safety Precautions in Using Farm Crop Driers

1. Store fuel outside of building in tanks or drums.

2. Follow manufacturer's directions.

3. Have an operator continuously with unit on first drying job. Thereafter he sould remain until sure unit is operating satisfactorily.

4. Unit should be equipped to shut off fuel if fan stops.

For shelled corn see USDA recommendations.

Iowa

For drying ear corn in fall or winter a temperature rise of 70 F is generally desirable. Two safety controls are needed. First, a high limit control, to shut the drier down if the temperature of the drying air exceeds a limit. Second, a control to shut the drier down in case of flame failure. When drying shelled corn the static pressure usually will be greater than for each corn which will result in a reduction in quantity of air delivered and therefore will call for a reduction in fuel rate. For summer operation this rate might be no more than 15 percent of the maximum. See USDA recommendations.

Kentucky

Heated air is necessary for ear corn if the kernel moisture content is above 30 percent. No temperature recommendations. Various types of commercial equipment are suitable. Units for producing heated air for drying hay are satisfactory. Combination fan, motor and heater units are avaialble. Most driers are designed to increase air temperature 20 to 80 degrees with capacities from 200 to 300 bu. per day.

Michigan

For ear corn and shelled corn see USDA recommendations.

Nebraska

Heated air is necessary for ear corn to assure safe conditioning when

Nebraska (Cont)

the moisture content is above 25 percent. Temperatures below 130 F apparently do not cause damage except when the corn is to be used for seed. Low temperatures are preferred for uniform drying of shelled corn. Air can be heated to between 10 and 25 degrees above outside temperature. 130 F or below is recommended.

RECOMMENDED CAPACITIES FOR DRYING 1,000 BUSHELS OF EAR CORN HAVING MOISTURE CONTENT OF 30% OR MORE (BASED ON OUTSIDE TEMPERATURE OF 50 F)

Heater Capacity (Oil) (Gal per hr)	Fan Capacity (cfm)	Drying Time (Approximate) (Days)
4.0	5,400	4 - 6
2.0	3,600	8 - 12
1.0	2,700	16 - 24
0.5	2,700	32 - 48

It is recommended that heated air always be above 50 F. In very cold weather the air flow may need to be restricted in order to maintain this temperature. Do not exceed 130 F. For shelled corn best results will be obtained if the air is heated between 10 and 25 degrees above outside air temperature.

Equipment for supplying heat should not be purchased before consulting a fire insurance company. Safety features should receive special attention. Several things to look for are:

1. Screened air opening to fan or furnace.
2. Filter for flue gas if mixed with drying air.
3. All-metal ducts close to furnace.
4. Automatic cut-off on burner if fan failure occurs.

North Carolina

For ear corn recommend an air temperature of 90 to 120 F. A heat capacity to give a rise of 25 degrees is needed for minimum air flow. For seed corn an air temperature of 100 to 110 F is recommended, with a heating capacity to give a temperature rise of at least 25 degrees for minimum air flow. For shelled corn recommend an air temperature of 90 to 110 F. A maximum temperature rise of 30 degrees is needed for minimum air flow.

Ohio

In drying ear corn for feed heat can be used but it is not absolutely necessary. All seed corn that is dried and held below 14 percent moisture during autumn, winter or spring must have artificial heat, whether the amount of corn is large or small. Steam or hot water systems may be used instead of hot air furnaces with good results. Air temperatures higher than 110 F should not be used in drying wet corn. To dry shelled

Ohio (Cont)

corn during winter it is necessary to heat the air about 20 or 25 degrees. May be possible to dry during autumn and spring using unheated air.

Oregon

A temperature of 160 to 175 F is recommended for drying ear corn for feed. For seed corn the temperature should probably be kept at 100 F and should not exceed 110 F. For temperatures not above 110 F a furnace with 188 sq. ft. of heating area will be satisfactory. For drying feed corn at 160 F the furnace should have at least 326 sq. ft. of heating area. Furnace sizes are for driers having a capacity of three tons of dry shelled corn at 12 percent moisture from undried corn at 30 percent per 24 hrs. at 160 F.

SPECIFICATIONS FOR EAR-CORN DRIERS

Drier Capacity (Tons) (1)	Bin Dimensions (Ft.) (2)	Air Volume (Cfm) (3)	Heating Surface (Sq. Ft.) (4)
1	4 x 10	4,000	113
2	6 x 13	7,800	220
3	9 x 13	11,700	386
4	9 x 18	16,200	450
5	10 x 19	19,000	528
6	12 x 19	22,800	635
8	15 x 20	30,000	835
10	19 x 20	38,000	1,060

(1)Tons of dry corn per 24 hours from 30 percent moisture.
(2)Size of bins for two-bin drier loaded to depth of three feet.
(3)Cubic feet per minute required for both bins.
(4)Heating surface required for temperature of 160 degrees F.

For shelled corn a temperature of from 160 to 175 F should be maintained for drying corn for feeding purposes. The capacity of the furnace must be adequate. The ratio of the heating surface to the grate area for forced-air circulation should not be less than 30 to 1 and may be as high as 50 to 1.

Texas

In college tests with ear corn the average temperature of the drying air was 185 F when corn was not dried for seed purposes. The drying air temperature should not exceed 115 F for seed corn. The heating equipment should be of sufficient size to provide approximately 20 Btu per 1,000 cfm of air per degree of temperature rise.

U. S. Department of Agriculture

For ear and shelled corn an upper limit of 130 F is recommended if corn is used as feed or for milling. For seed corn this limit is 110 F. In mild weather a temperature rise of 10 to 20 degrees may be sufficient. Drying can be done most economically with a portable drier for transfer between cribs or even farms. Fuel oil, propane or coal and other solids can be used as fuel. Direct heat units may use fuel oil or gas. The heat exchanger type may discharge from 25 to 35 percent of the fuel heat value to the atmosphere. Good fuel economy is obtained by drying in large batches. Generally when the drying air temperature is above 90 F the drying time should not exceed 100 hours. (See operating instructions) See USDA references Nos. 1, 2, 3, 4, 5, 6, 8, 9, 11, 12.

Wisconsin

For ear corn recommend air temperature of 80 to 100 F and should at no time exceed 135 F.

Cowpeas

Texas

In college tests with cowpeas the air was heated to an average temperature of 118 F underneath the sacks. This air temperature had no detrimental effect on the germination of the seed. Heating equipment should furnish at least 20 Btu per 1,000 cfm of air per degree of temperature rise.

Flax

Texas

The most efficient air temperature for drying flax seed from 10 to 11 percent to 7 percent moisture with a column type drier was 150 F; for drying seed from 15 to 16 percent moisture to 7 percent, recommend a minimum of 175 F.

Grain Sorghum

North Carolina

For grain sorghum recommend an air temperature of 90 to 120 F.

Texas

For grain sorghum at 14 to 16 percent moisture recommend air at 150 F; 17 to 20 percent, 175 F; above 20 percent, 200 F. In college tests using a batch type drier heat was supplied by a low pressure injector type burner rated at 500,000 Btu per hour based on 0.1 inch draft. Fuel was natural gas. LP gas has been used with good results.

U. S. Department of Agriculture

For grain sorghum use same recommendations as for "Barley". See USDA references Nos. 2, 3, 6, 8.

Grain

Alabama

All installations for drying grain should be equipped for supplying additional heat.

Nebraska

For grain higher temperature aids drying but final moisture content is determined by the humidity of the air.

Hay

Alabama

Recommend all hay drying installations be equipped for supplying additional heat.

California

If possible locate blower inlet on south side. Warm air dries hay more rapidly.

Connecticut

Heat is not recommended for hay drying at present for average New England farm because of cost. It adds other problems, one of which is the fire hazard.

Indiana

For hay the use of heat is still in the experimental stage. By heating air 20 to 30 degrees, the drying time will be reduced at least one-half and total cost per ton will remain the same as for unheated air. A unit for drying hay on wagons has given good results. An indirect unit approved by Underwriters Laboratories has been satisfactory for drying baled and long hay. Heater units used for corn drying will dry some hay. Units are limited in their capacity. Drying too much hay at one time may result in mold in the outer layers. Most efficient operation has not been established.

Kentucky

Use unheated air for drying hay.

Maine

The use of supplemental heat in drying hay is seldom warranted for the average farmer. Auxiliary heat increases the rate of water removal but adds other problems, one of which is the fire hazard.

New Hampshire

See Maine.

North Carolina

For loose hay recommend an air temperature from atmospheric to 120 F. Maximum temperature rise of 30 degrees is needed for minimum air flow. Chopped hay requirements are same as for loose hay.

Ohio

For baled hay extra heat can be used but it is not necessary.

Oregon

For hay the more the air is heated the faster will be the rate of drying. Large heaters are not usually justified for the short operating season. Temperature increases of from 10 to 40 degrees are most practical and cut the drying time from one-quarter to one-half of that required with unheated air. For the coastal region supplemental heat is recommended.

Tennessee Valley Authority

For drying hay the use of supplemental heat is not normally needed for successful operation of driers in most sections of the country. In some of the more humid areas heat may be necessary.

Advantages of supplemental heat:

a. Shortens drying time and makes possible loading of several batches during one cutting.

b. Increases effective hours of operation per day.

c. High quality hay during unfavorable weather.

d. Can handle hay with higher moisture and at greater depths.

e. Adaptable for drying other crops.

Tennessee Valley Authority (Cont)

Disadvantages of supplemental heat:

a. Fire hazard.

b. Higher first cost.

c. Increases labor required.

d. Increases operating cost per ton of dry hay. (This is subject to question in light of more recent data.)

Sources of supplemental heat:

a. Solar heat. High cost of utilizing it.

b. Electric heat. High cost and too large transformer capacity needed.

c. Hot air furnace. Satisfactory but needs safety controls.

d. Steam and hot water. This is safe and dependable.

e. Gasoline engine heat. Satisfactory but precautions must be taken in its installtion and operation.

Texas

For alfalfa hay the desirable air temperature is between 145 and 150 F for trailer method of drying.

U. S. Department of Agriculture

In hay drying additional heat may or may not be used. In sections where humidity is high, additional heat is necessary. Tests indicate a temperature rise of 25 degrees reduces the drying time by two-thirds; increases the operating cost only a few cents more; increases the total cost due to additional equipment and improves the quality. In general supplemental heat is a necessity in come areas and good insurance against bad drying weather in others. See USDA reference No. 10.

Vermont

See Maine.

Washington

In college tests with pea vines two butane burners heated the incoming air. The use of heated air at 176 F for the initial two hours of drier operation proved uneconomical. In other tests with beet top hay no heat was used.

Wisconsin

A 5 to 10 degree air temperature increase is highly desirable on damp days and at night. The increase should not be greater than 20 degrees. If a gasoline engine is used, all possible waste heat should be salvaged, however, precautions must be taken to eliminate the chance of fire. Considerable care should be exercised in selecting commercial drying units for barn hay drying. They should have a capacity of 20,000 to 30,000 cfm at 1.25 in. static pressure with provision for reducing the fan output. The heat unit should have capacity to burn two to three gallons of fuel or 20 to 30 lbs. of coal per hour with provision to reduce this one-half or entirely. Provision should be made for elimination of sparks and for incorporation of adequate safety and control features commonly found on similar domestic equipment. Automatic fire extinguishing equipment is also desirable.

Oats

North Carolina

For oats recommend an air temperature of 100 to 120 F.

U. S. Department of Agriculture

See "Barley". See USDA references 2, 3, 6.

Peanuts

Alabama

For peanuts recommend an air temperature of 115 F.

Georgia

For peanuts a safe temperature for heated air is 100 F.

North Carolina

For peanuts to be used for oil stock recommend an air temperature of 85 to 120 F.

Oklahoma

For peanuts the air duct temperature ranged from 115 to 125 F. Heated air was produced by a portable drying unit equipped for burning kerosene or fuel oil.

Texas

Drying air temperature of 125 F can be used for peanuts with 18 percent or less moisture content without effecting germination or milling quality.

Potatoes

North Carolina

Recommend an air temperature of 85 F for curing sweet potatoes. For storage a temperature of 50 to 55 F.

South Carolina

For sweet potatoes temperatures should be maintained as follows:

Curing period - 80 to 85 F.

Storage period - 50 to 55 F.

Generally stoves do not maintain uniform temperatures and humidity throughout the storage house. Electric heaters do maintain uniform temperatures. Both strip type heaters and soil heating cable were used. The strip heaters maintained the temperatures required for various periods of curing and storage. Temperatures above 90 F may cause root decay.

U. S. Department of Agriculture

For white potatoes the following is recommended:

Wound healing period - 60 F

Holding period - 50 F short time (three or four months)
40 F for long time storage

Warming period - 50 F

See USDA reference No. 2.

Rice

Arkansas

Germination is reduced when rice is dried at air temperatures above 130 F. The total drying time is reduced as drying temperatures are increased for a

Arkansas (Cont)

given number of dryings. In most cases head rice yield is increased as the number of dryings is increased from one to four at temperatures ranging from 100 to 150 F. At lower temperatures, 100 F and 110 F, this increase is smaller than at higher temperatures. Temperature is the best known indicator of the condition of rice in storage and all storages should be equipped with temperature measuring equipment. When the temperature reaches 100 F the rice should be dried or aerated. Rice has been permitted to go to 115 F for a short time and then dried without reducing milling yields and germination. Rice usually cannot be combined and stored longer than 24 hours without heating and subsequent damage.

California

For rice drying, temperatures near 100 F are satisfactory. Bulk rice driers vary in size from 3 to 25 tons per hour on basis of complete drying by removing 8 to 10 percent moisture. All blow heated air through columns of rice. Heat may be supplied by butane, natural gas or oil. A few sack driers are in use but they are not as popular or efficient as the bulk types.

Texas

For drying seed rice in sacks use 135 F for moisture range of 15 percent or lower; 125 F for moisture of 15 to 20 percent; 120 F for moisture of 20 to 24 percent.

Rye

U. S. Department of Agriculture

See "Barley". See USDA references Nos. 2, 3, 6.

Seeds

Alabama

For seeds recommend a 20 to 40 degree temperature rise. Germination is endangered at temperatures above 115 F. Plans specify a heating unit capacity of 70,000 (plus or minus 50 percent) Btu per hr., thermostatically controlled.

Georgia

Heated air can be used for drying seeds. Use same recommendations as for seed corn.

North Carolina

For lespedeza seed recommend an air temperature of 60 to 110 F. Maximum temperature rise of 30 degrees is needed for minimum air flow. For seed cotton recommend a minimum air temperature of 60 F. A maximum temperature rise of 30 degrees is needed for minimum air flow.

Texas

In college tests with Rescue grass seed the average temperature of the heated air was about 120 F. For Dallis grass seed the average temperature of the drying air was 119 F and 21 degrees above atmospheric. Never exceed 120 F.

Soybeans

North Carolina

For soybeans recommend an air temperature of 90 to 120 F. Heating capacity to give a temperature rise of 40 degrees is needed for minimum air flow.

U. S. Department of Agriculture

See "Barley". See USDA references Nos. 2, 3, 6.

Sugar Beets

Colorado

For sugar beets no heat is needed. There is little doubt that artificial ventilation of sugar beet storage piles can be beneficial especially in climates having temperatures below 40 F at night during harvesting and storing season. Frozen beets cannot be tolerated and the quantity of wilted and warm beets must be kept at a minimum. Beets should not be exposed to the sun for in several hours they will absorb a large amount of heat and destruction of beet tissue will follow. Living sugar beet tissue begins to decompose at temperatures above approximately 65 F and increases rapidly as the temperature increases. Temperature readings in the pile are very difficult to take accurately. For best storage the temperature must be reduced from about 50 F, the average temperature of the soil at harvest time in Colorado, to as near 32 F as possible without freezing.

Michigan

For sugar beets no heat is required. However, the temperatures of sugar beet storage piles should be checked at four-hour intervals. The ambient air should be blown into the pile when it is five to six degrees colder than the hottest spot in the pile.

Tobacco

North Carolina

For bright leaf tobacco recommend a maximum air temperature of 200 F.

Stage of Cure	Critical Temperatures (Degrees F.)
Yellowing	4 to 8 above outside temperature
Color setting	105, 110, 120
Drying	140
Killing	170

Wheat

Nebraska

Drying of wheat can be done with or without heat. Heated air generally will not be needed since Nebraska temperatures and humidity are favorable to air curing at harvest time. However, heat may be necessary under extremely adverse conditions in making possible the saving of a crop. See "Corn".

North Carolina

For wheat recommend an air temperature of 100 to 120 F.

U. S. Department of Agriculture

See "Barley". See USDA references Nos. 2, 3, 6.

Barley

North Carolina

For barley use the farm crop drier or tobacco barn drier as designed by the college, grain sorghum drier by Texas, rice drier by Louisiana or metal bin with perforated floor.

U. S. Department of Agriculture

In drying barley the structure must hold the grain without loss of quantity; exclude rain, snow and ground moisture; afford reasonable protection against thieves, rodents, birds, poultry, insects and objectionable odors; permit effective fumigation; be reasonably safe from fire and wind damage; be of reasonable cost; and have permanence, low upkeep and convenience of filling and emptying. The foundation should be such as to prevent damage to structure from uneven settling or ground frost. Wood, steel and concrete floors have been used and are satisfactory if properly built. A temporary floor of asphalted roll felt roofing with cemented lapped joints on the ground has been successful. Galvanized sheet steel floors on earth or gravel fill have been used generally in round steel bins. Preferred construction of wood bins calls for two layers of outside material with a layer of waterproof material between and no lining on inside of studs. In steel bins using galvanized steel sheets, leakage can be minimized by using lead washers; tightening the bolts well, without squeezing the lead washer out of position; and use of suitable gaskets at vertical joints and around doors. Bin roofs must be watertight. Doors should be carefully fitted. Plans are available from State Agricultural Extension Services. See USDA references Nos. 2, 3, 6.

Beans

Washington

For beans a small pilot drier was used for college tests.

Broomcorn

Texas

For broomcorn a tray type drier has been found to be the most satisfactory for this crop. Loose broomcorn is placed in the tray six inches deep. Trays were made of 1 x 2 in. slats.

Georgia

For seed corn provide one square foot of duct area for each 1,000 cfm of air supplied. The simplest arrangement is to provide a perforated or slatted floor in a bin having tight walls and blow the air upward through the corn. Slatted cribs can be used by fastening a canvas duct to the side of the crib. Seal the wall above the duct with roofing paper, kraft paper, canvas or other material up to the height of the corn. The distance from the top of the duct to level of the corn must be about the same as the crib width. It is best to run the duct the full length of the crib. The distance the air must travel through the corn should be the same at all points.

Illinois

For ear corn and shelled corn see USDA recommendations.

Indiana

Ear corn drying is most efficient in bins having tight sides and floor, and with a false floor 12 to 18 in. above it. One of the most practical methods is to adapt a single-slatted crib by using a canvas duct along one side. The duct should be at least one square foot cross section for each 1,000 cfm of air. Provide air-tight floor and seal walls up to height of corn. Air must pass through the corn uniformly in all directions. A double crib without overhead bins can be adapted by constructing a slatted duct through the center of the driveway for the entire length of the crib. and filling the driveway as well as the cribs on each side of the driveway. Silos can be adapted by building a false floor. Depths up to 25 feet can be dried. Temporary cribs can be built of snow fence or welded wire, using a false floor arrangement with the sides made tight by lining with a reinforced waterproof paper. Also a tunnel and a slatted duct can be placed in the center and running the full length in case of a rectangualr crib, or a slatted central chamber connected to the outside with a duct in a circular crib. For shelled corn see USDA recommendations.

Iowa

For ear and shelled corn see USDA recommendations.

Kentucky

In curing ear corn with natural ventilation, special flues are recommended. These may be of the A-frame or vertical wall type. In any case it is advisable to design and install the flues so that forced air can be applied if necessary. Most cribs can be adpated for forced air curing. Crib width should be limited to 10 ft., preferably 8 ft. Cribs wider than four feet are often unsuitable for soft corn unless special methods of ventilation are used. For single cribs an air duct along the side is preferred to a ventilator through the center. Double cribs can be adapted by closing off driveway and using it as the air duct. In tight-wall cribs install an elevated slatted floor over entire floor area and use the space under it as an

Kentucky (Cont)

air duct. In round cribs provide a vertical ventilator three to four feet square or three to four feet in diameter in center of crib. An air duct can be constructed underneath the crib to take air to the vertical duct. Provide the ventilator with a baffle which can be adjusted so that it can always be placed five to six feet below the top of the corn. The distance from the edge of the ventilator to the edge of the crib should not be over nine feet.

Michigan

For ear corn and shelled corn see USDA recommendations.

Nebraska

For ear corn most cribs and bins can be readily adapted for forced ventilation. Care must be taken in all cases to reduce air leakage to the minimum particularly along cross braces and provide a uniform air flow through all the corn. It is important that the air pass through the same thickness of corn in all directions before it escapes. Air ducts can be formed and covered with reinforced craft paper or water-tight canvas. Double cribs with or without overhead bins can be adapted by closing off the driveway and using it for the main air duct. Circular temporary storages can be adpated by constructing an air tight duct about three to four feet square from the outside to a central perforated vertical duct of the same size. Another method is to install a raised perforated floor in the crib and make the sides and ends air tight. Depths up to eight feet can be dried in this manner. For shelled corn bins can be adpated for drying by installing canvas duct along one side or a wood duct down the center or along the side of the bin with laterals. The side main construction is recommended for bins up to 12 ft. wide and main duct through center of bin for widths over 12 ft. Metal perforated flooring can be used successfully but it must be installed carefully to avoid leaks. It is somewhat inconvenient to clean. The perforation area should be at least 7 to 10 percent of the floor area. Such materials as landing mat, hardware cloth and others properly supported and covered with fly-screen wire can be used in emergencies. At least 1.5 sq. ft. of inlet area should be provided per 1,000 bu. of grain or one square foot per 1,000 cfm of air delivered. The outlet should have at least double the area of the inlet. Tight bins, preferably with double walls and dry floors, are recommended. The exterior should be painted with white, aluminum or other heat-reflecting paint. Plans are available through County Extension Agents.

North Carolina

For ear corn use farm crop drier or tobacco barn drier as designed by college. It may be dried loose in bins or on a slatted floor. Existing cribs can often be used. For seed corn use farm crop drier, tobacco barn drier or hybrid seed corn drier as designed by college. For shelled corn use grain sorghum drier by Texas, rice drier by Louisiana or metal bin with perforated floor.

Ohio

Walls of cribs and bins should be airtight at least up to the height of the stored ear corn. Flues and slatted floors similar to those in hay driers may be used. Mow hay drier systems have been used successfully. The slatted floor should be placed from one to two feet above the regular floor. There are many bin variations which are satisfactory for drying purposes. In drying corn for seed the batch type is not recommended as it requires excessive handling. One-story buildings are preferable with a steep pitch roof, 9-foot rise to 12-foot run or steeper. This permits space for conveyers, sorting or cleaning seed corn or extra bins. For shelled corn all bins used had perforated floors built above the original floor. A perforated metal floor gives good results and perforated plywood appears satisfactory. Flues and slatted floors similar to hay driers may be used bu cracks must be covered with screen. A wood slat floor may be made from 1 x 2 in. or 1 x 3 in. boards spaced one-eighth inch apart. Beveling on the underside will reduce clogging.

Oregon

In general bins with slatted bottoms have been used for ear corn. Plans for a drier with a capacity of three tons of shelled corn per day are available from the college. Shelled corn driers must be constructed so that air can be effectively distributed to remove heat from the furnace and to utilize the heat in evaporating water from the material to be dried. The drier used in experiments was a continuous-process vertical-column type. The drive for the draw-off rolls may better be a motor with built-in reduction gear to produce about 30 rpm rather than a belt driven speed reducer. Air ducts may be either cylindrical or rectangular depending on convenience and cost. Where rectangulat ducts are used height and width should be as equal as possible and not exceed a 1 to 10 ratio. Unnecessary turns in the ducts should be avoided and the radius of the turn should be between 1.5 to 2 times the duct diameter. Air friction losses in ducts and around the furnace should not exceed 0.2 in. of water when a pressure of 0.7 in. of water is required. A rectangular duct should have a 10 percent greater cross-section than a round duct.

Texas

In college tests with ear corn a sub-floor type drier was satisfactory.

U. S. Department of Agriculture

Most farm cribs can be prepared for mechanical drying of ear and shelled corn after they have been filled. Some types of ventilators will interfere with forced air distribution and may need to be blocked or removed before the crib is filled. The air must enter and leave the crib so that it travels about the same distance through the corn in all parts of the crib. In cribs without ventilators a canvas duct can be attached to one side through which the air can be blown. The duct should be at least one square foot in area for each 1,000 cfm of air delivered by the blower. In double cribs the driveway can be used as an air duct. Steel circular bins with false floors may be used. The floor can be of hardware cloth, perforated

U. S. Department of Agriculture (Cont)

metal or expanded metal laid on joists supported by concrete blocks. A system of main and lateral ducts has also been used. Shelled corn may be dried in a continuous-flow drier such as used by some elevators. Continuous-flow driers have been developed for drying rice on farms, but have not been used very extensively for drying corn or other grains in some areas. See USDA references Nos. 1, 2, 3, 4, 5, 6, 8, 9, 11, 12.

Wisconsin

For ear corn prefer a structure with tight sides and a slatted floor approximately 50 percent of which is open. These are usually built of 1 x 4 in. boards set on edge with short pieces of 1 x 4's used as spacers between the full length strips. Any type would be satisfactory as long as a slatted floor could be installed and the air could be blown vertically through the corn.

Cottonseed

Texas

The lateral system is satisfactory for aerating cotton seed.

Cowpeas

Texas

In college tests with cowpeas a small bin with sub-floor was used.

Flax

Texas

A column type drier with flax column 10 in. thick proved satisfactory.

Grain Sorghum

North Carolina

For grain sorghum use farm crop drier as designed by the college, grain sorghum drier by Texas, rice drier by Louisiana or metal bin with perforated floor.

Texas

In college tests with grain sorghum an all steel batch type farm drier with 10 in. width columns designed by the Experiment Station was used. Bin driers with sub-floors were also used.

U. S. Department of Agriculture

See "Barley". See USDA references Nos. 2, 3, 6, 8.

Grain

Alabama

Plans are available.

Nebraska

Same as for "Shelled Corn".

Tennessee Valley Authority

For grain tapered floor ducts with hardware cloth or screen wire covering open sides give best air distribution when spaced 24 in. on center in small bins. Round bins proved satisfactory when constructed properly. Good results were also obtained in drying grain with conventional hay drier system, both in sacks and in the bin. If the haymow floor or similar equipment is not used a perforated or screened floor is satisfactory.

Hay

California

Provide a door in main duct. Laterals should not be more than 25 ft. long. For barns 30 ft. or more wide a central main duct should be used with laterals or slatted floor on each side. For barns less than 20 ft. wide a single high, narrow, slatted central main duct without laterals may be used. For long hay recommend slatted floor or lateral type with vertical flues for a storage depth greater than 12 ft. If lateral type is used the space between the laterals should be four to five feet. Minimum space between laterals and walls is six feet. For chopped hay recommend lateral or slatted floor systems with vertical flues for storage depths greater than 12 ft. Space between laterals should be four to five feet. Minimum space between laterals and walls should be six feet. For baled hay recommend slatted floor with side main duct. Minimum space between slatted floor and side walls should be five feet or if side walls are air tight this can be two feet.

Connecticut

For hay the area of fan intake should be 1.5 times the cross sectional area of plenum chamber. The height of the main duct opening to the slatted floor should be a minimum of eight inches. The minimum height of the slatted floor joists or sleepers should be six inches. Both slatted floor or laterals are recommended. Vertical formers are suggested for depths of chopped and long hay beyond 18 ft. Spacing of

Connecticut (Cont)

vertical formers is entirely arbitrary. However, one is needed, roughly for every 100 sq. ft. of floor area. Dimensions are arbitrary. However, the college used plywood boxes, 16 in. square by four feet long, as this fits standard plywood dimensions. The boxes are closed at each end with a hand hole at one end. They are set on the slatted floor when starting to fill the mow. After a depth of four feet is reached they are lifted about three feet. This is continued until mow is filled to about 18 feet. Beyond this depth they are removed. Openings totaling four times the fan area must be provided for ventilating the mow space above the hay. The main duct may be located in the center or at one side. The side type can be used successfully in barns up to 40 ft. wide. A single slatted duct can serve narrow mows up to 20 ft. wide. This duct may also be made of bales of hay with proper overhead reinforcing. A six foot extension from the fan house into the pile is necessary to avoid air loss. Install a door into the main duct with a handle on the inside. Installation may be made in any barn with a leak-proof roof and dust free floors. Dust free dirt floors may be used. The sides need not be tight. It may be less expensive to build a one-story fire resistant stable and an inexpensive hay shelter with a hay drier rather than a silo. If a new barn must be constructed it may be cheaper to build a silo for grass silage and a one-story fire resistant stable. Open haystacks may be used if protected from rain. Since 20 to 50 percent more hay will be stored in the same place where mow dried, supporting timbers may need reinforcement.

Indiana

No one hay drying system is best for all barns. Construction must be such that air travels equal distances in all directions from the duct to the hay surface.

1. Slatted floor type:

This works best when walls are sealed on inside of studs. It can work in any size of barn with four tight walls by tramping hay against walls to reduce leakage. If walls are not air-tight the slatted floor should end six feet from the wall. The main tunnel should be air-tight. The slatted floor type is the best system for wide barns. However, it requires more lumber and is the most difficult system to load evenly.

2. Triangular duct type:

This is a simplified method for long or chopped hay. The hay must be placed at a uniform thickness over the duct. A wire net fastened to the wall studs will allow air to escape from the hay in contact with walls.

3. Rectangular duct type:

It can be used for chopped, baled or long hay. The duct can be slatted or covered with wire and built down the center of the barn.

Indiana (Cont)

General recommendations:

1. Floor, as well as hay chutes and other openings, must be air-tight.

2. Supporting members of the mow must be adequate.

3. Supply adequate ventilation above the hay.

Size of Fan	Size of Opening above Hay
5 Hp.	100 Sq. Ft.
$7\frac{1}{2}$ Hp.	150 Sq. Ft.
10 Hp.	200 Sq. Ft.

4. Locate fan and air intake where sun strikes most of the time. Air intake for fan should be twice fan outlet size.

Kentucky

If barn loft is used for drying hay the floor must be tight and the roof leakproof. The drier can be placed on the ground if it is well tamped and clean. A concrete floor is best if a separate drier is built. Adequate ventilation is essential. Damp air from the hay should not be allowed to recirculate. Hay chutes may need to be relocated. When designing a systen such obstacles must be considered.

Maine

For hay the opening from the fan to the outside air should be at least twice the fan area, and should be on the south or west side of barn. The floor must be tight and the mow roof must be leak-proof. Dust free dirt floors may be used. The sides need not be tight. Supporting timbers may need reinforcing. Openings totaling at least four times the fan area must be provided above the hay. Supplemental exhaust fans may be required for this purpose. The main duct may be on the side although the center type is preferred. Barns up to 36 ft. wide can be served by side main ducts. The main duct should be square and have an area of at least one square foot for each 1,000 cfm of fan deliver. Install a door leading into the main duct with a handle on the inside. In wide mows lateral ducts or slatted floor openings should total at least 110 percent of the main duct cross section. In narrow mows up to 20 ft. in width a slatted main duct may be sufficient. When this duct is made of bales of hay a six foot extension from the fan into the pile is necessary to prevent loss of air.

Michigan

For depths up to 15 ft. of long hay or 12 ft. of chopped hay the main duct may be in the center of along one side. For greater depths the main duct should be in the center of the mow and be provided with two sets of doors, one on top and one on the bottom. The duct may have any convenient shape although it is desirable to have it high enough so that a man can walk erect in it. It should have a cross sectional area of one square foot for each 1,000 cfm of air needed. The inside may be lined with any material

Michigan (Cont)

that is reasonably air tight. Convenient access to the duct is desirable. Hay chutes may pass through the main duct but they should be equipped with air tight doors. The slatted floor is most popular when used with a center main duct and may either be step tapered or rip tapered, that is, joists are cut to a gradual taper. Floor joists or girders should be strong. The floor must be air tight and the roof leak-proof. The slatted triangular tunnel is recommended for chopped hay only and for a mow width of 30 ft. or less and to a length of approximately 40 ft. which can be conveniently covered with one setting of the hay blower. If air control doors are used the triangular tunnel length may be increased to accommodate two or more blower settings.

New Hampshire

See "Maine" - except that the opening from the fan to the outside air should be at least twice the fan area whenever possible. Fan may be located anywhere on barn.

North Carolina

For hay use farm crop drier or barn hay drier as designed by the college.

Ohio

For hay the main tunnel may be in the center or along either side or end of the drying area. The mow floor should be reasonably airtight. Reinforced paper may be used to cover open spaced mow floors. Bent-type barns may be fitted with a single large duct along the center. For chopped hay the slatted floor design is preferable. For baled hay it seems desirable to have a continuous air chamber under the bales to distribute the air uniformly. Good design would be to have joists with slats or joists close enough, 12 in on center, so that the bales rest directly on them. For long hay either the slatted or lateral duct system can be used. Long hay may also be dried in the stack.

Oregon

In general the barn should have an air-tight floor, a good roof with adequate mow ventialtion and a hay track and fork. The slatted floor appears to be preferable as it gives more uniform air distribution and is easier to load and unload. The open area between the slats should be 25 percent greater than the cross section area of main duct. A circular hay keeper has been designed and plans are available from the college.

Pennsylvania

For hay mows not exceeding 24 ft. in width use a single center duct, with sides and top covered with slats, fence wire or turkey netting. If slats

Pennsylvania (Cont)

are used they should be narrow and spaced wide apart. For wider mows use same main duct but include a slatted floor extending not closer than six feet from mow edge.

AVERAGE DUCT SIZES

Fan Unit	Average Duct Size
3 Hp.	14 Sq. Ft.
5 Hp.	21 Sq. Ft.
$7\frac{1}{2}$ Hp.	31 Sq. Ft.

The horizontal distance from duct to mow edge should equal vertical distances from top of duct to top of mow within two feet. The hayair contact area in square feet shall equal one fiftieth of cfm required for drying so speed of air entering hay is below 50 fpm. In high mows vertical flues to within four feet of top of mow will aid air distribution .

Tennessee Valley Authority

A self-supporting roof of the gambrel or Gothic type may be considered ideal for any type of hay storage. The storage space must be dry. The mow must be adequately ventilated above the hay. An air tight floor is essential. A well-laid tongue and groove floor or a floor of two thicknesses of dressed or rough boards with building paper between are satisfactory. Holes or chutes should be provided for removal of the hay. Locate so as to cause least interference with duct system. Laterals should not extend closer to them than their end distance from the side walls. A hay track and a special grab fork are needed for handling hay of 40 to 50 percent moisture content. Standard handling equipment is satisfactory if good judgement is used in loading the fork. In selecting the drier system the following criteria may be used as a guide:

Use single main system:

a. For barn widths up to 40 ft. and when fan unit can be mounted at one end.

b. When mow area does not exceed fan unit limitations.

c. When mow area exceeds fan limitations but amount of hay will be from four to eight feet in depth and total depth in one season not to exceed 16 ft., or when each batch can be removed and stored elsewhere.

Use side main system:

a. For mows less than 30 ft. wide.

b. Do not want center main duct.

Tennessee Valley Authority (Cont)

Use divided main system:

a. Where single main is not suited and where fan unit can be located at either end.

b. Where hay tonnage is small and only part of system needs to be operated.

Use divided main, alternate blowing system:

a. Where mow area is too large for fan unit and small tonnage of hay is handled. (Four to eight feet deep)

b. When two types of hay are cured separately.

Use one or more single main systems connected to delivery duct:

a. When mow width exceeds 40 ft.

b. When location of hay chutes makes location of ducts on long axis of barn impractical.

c. When lean-to on building affords most practical location for fan unit.

Texas

For long alfalfa hay, lateral and sub-floor systems were used in c llege tests. Wire laterals gave more uniform drying than wooden ones. The lateral method was used in first tests. Sub-floor type is recommended now. For baled hay, lateral systems were first used. Sub-floor method is recommended at present. For chopped hay, a rotary drum dehydrator and a farm trailer were both used in college tests. The trailer was supplied with heated air by a commercial portable type drier. The trailer had wire mesh sides, a wire air duct with an air-tight bottom. A six inch strip of wood to hold the sides in place was satisfactory. Practically all air loss can be eliminated by lining with heavy building paper but this can only be a temporary measure. A trailer bed sould be lined with sheet metal for best results. There should be no solid siding around the trailer. The air duct should be large enough to allow a maximum of two feet from the sides of the duct to the sides of the trailer in all directions. The tail gate should be made solid with an opening to serve as the air inlet to the duct. Chopped hay can also be dried in bins using the sub-floor system. Very little peanut hay is dried at present. When it is, sub-floor driers are used.

U. S. Department of Agriculture

For hay a mow drier can be installed in almost any type of hay mow or hay shed. It should have a leak-proof roof. The floor should be made tight to prevent air leakage. Adequate ventilation should be provided above the

U. S. Department of Agriculture (Cont)

the hay. Obstructions such as hay chutes, posts and braces are objectionable. However, the air distribution system can reduce these effects if designed properly. The structure must be strong enough to stand the additional weight which may be double or triple the normal load. Either the lateral duct or slatted floor systems can be used. However, the slatted floor provides more even and efficient air distribution, is easier to construct, and requires no finished lumber or experienced carpentry. See USDA reference No. 10.

Vermont

See "Maine".

Virginia

For alfalfa hay the roof should be in good condition. Columns are objectionable and a self-supporting type of roof is desirable but not necessary. The floor should be strong and air-tight. Adequate ventilation above the mow is necessary and the combined area of these openings should be at least one square foot for each 200 cfm of air delivered by the fan. Recirculation of air should not be permitted. Provide convenient hay chutes. Air should not be discharged closer than five feet to hay chutes or two feet to posts or other obstructions. Hay sheds can meet all requirements. If they have a well drained dirt floor, the drier can give good results. The slatted floor type of drying system is recommended.

Washington

Driers used for pea vines were 10 by 80 ft. formed by a concrete wall six inches thick and two feet high with a dirt floor. The drier floor was constructed on this wall with 2 x 4 in. joists 10 ft. long spaced with 2 x 4 in. blocks six inches long. A one foot overhang was designed to prevent air leakage through the sides. At each end a three foot propeller fan was installed and the drier was divided into two sections so that one half could be loaded at a time.

Wisconsin

Mow floor must be air tight and may need reinforcing if chopped hay is dried. Barn driers have been designed primarily for existing structures. If new ones are to be built then consider such matters, as making more grass as well as corn silage, field chopping and reducing labor for care of livestock. The slatted floor type is desirable. The slatted floor should extend to within six feet of the edge of mow or sidewall and left open at the edge. Outer one-half can be portable for easy removal and storage. Stringers under the floor should not exceed two feet on centers and it is best to place them directly over the floor joist. Locate the main duct in the center or on the side, if the hay depth does not exceed 10 or 12 ft. See college plans for further details.

Nuts

Oregon

For filberts and walnuts use same drier as for ear corn.

West Virginia

Plans are available from the college for walnut meat pasturizer.

Oats

North Carolina

For oats use farm crop drier or tobacco barn drier as designed by the college, or metal bin with perforated floor.

U. S. Department of Agriculture

See "Barley". See USDA references Nos. 3, 11, 12.

Peanuts

Georgia

For peanuts construct the drier so that the air can be directed from top to bottom as well as bottom to top if depths greater than three feet are to be used. A perforated floor type drier is recommended so that the peanuts can be spread out.

North Carolina

For peanuts for oil stock use farm crop drier or tobacco barn drier developed by the college, or metal bin with perforated floor.

Oklahoma

For peanuts the slatted floor type drier was used in college tests.

Texas

For peanuts generally use slatted sub-floor system or portable air distribution system. The sub-floor should be 24 to 30 in. above the bin floor. A portable air distribution system has been used with excellent results and may consist of a removable tunnel made in two-foot sections of heavy welded wire mesh. This tunnel may be made of wood. Peanuts may be dried in bulk also, using a column type drier. Tests indicate that the column width should not exceed 16 in.

Potatoes

North Carolina

For sweet potatoes use standard curing house (USDA plan), converted tobacco barn (Extension Service plan), or slatted floor of farm crop drier. Existing structures can often be used.

South Carolina

For sweet potatoes the building must be sanitary and capable of being cleaned to eliminate rot organisms, also tight and well insulated with positive ventilation controls. Heat supply must be well distributed to prevent hot or cold spots and wide temperature fluctuations. Light might better be supplied by electric lights rather than windows. A filled dirt floor is cheaper and allows for ease of maintaining the humidity. Air ducts should come from below and all doors and ventilators should be weather stripped.

U. S. Department of Agriculture

For white potatoes the simplest method is pitting or mounding, and success depends on having a well drained site and adjusting the pit depth and potato covering to suit the weather and storage period. Common practice is a pit 6 to 12 ft. wide and one to three feet deep covered with a foot of straw and six inches of earth. Basement storages are used but are likely to be unfit for the purpose. If more than 8 to 10 bu. are stored a space should be partitioned off and insulated. If above ground structures are used, however, provision for heat must be made. Single drive earth covered houses are widely used and are adapted to high altitude areas where nights are cold, the days mild and sunny, and rainfall low. A number of storages are built of concrete which may require heat. Some types of storages are partly above and partly below the ground with work alleys at two levels. Insulation will usually be required. See USDA reference No. 7.

Rice

Arkansas

For rice provide adequate ventilation especially at the top of the bins. Materials which are impervious and prevent the escape of water-bearing vapor should not be used. Most driers are commercially built and used for custom drying.

Texas

In college tests with rice a tunnel-type sack drier was used.

Rye

U. S. Department of Agriculture

See "Barley". See USDA references Nos. 2, 3, 6.

Seeds

Alabama

Plans are available for seed driers; one small and one medium size drier.

Georgia

For seeds use platform or bin type driers, or vertical screened column type similar to the equipment developed by the Agricultural and Mechanical College of Texas. In the platform or bin type a slatted floor covered with hardware cloth or perforated steel floor is supported above building floor.

North Carolina

For lespedeza seed and seed cotton use farm crop drier or tobacco barn drier as designed by college, or metal bin with perforated floor.

Texas

For Sudan grass seed generally use the tunnel type of drier, when dried in sacks. Bin or column type driers are satisfactory for drying in bulk. For Rescue grass seed the column-type drier with minor changes is well adapted to drying this crop. In college tests with Dallis grass seed small bins with lateral system or sub-floors were used. Laterals were covered with 1 x 1 in. steel wire.

West Virginia

Plans are available from the college for a seed treater and drier.

Soybeans

North Carolina

For soybeans use farm crop drier or tobacco barn drier developed by the college; grain sorghum drier by Texas, rice drier by Louisiana or metal bins with perforated floor.

U. S. Department of Agriculture

See "Barley". See USDA references Nos. 2, 3, 6.

Sugar Beets

Colorado

For sugar beets it is important that air ducts and the distributing system be of adequate size and proper design. (See AIR REQUIREMENTS.) Poor

Colorado (Cont)

design has been responsible for most of the discouraging results in the past. Whether the installation should be temporary or permanent depends on the particular circumstances prevailing. Further study will be needed to determine whether permanent structures would be practical.

Tobacco

North Carolina

For curing bright leaf tobacco recommend a tobacco barn. Theoretical area for ventilators in the four-room barn, nominal 16 x 16 ft., is 2.5 square feet of intake and three square feet of outlet. A larger barn requires more ventilation in direct ratio to the number of sticks housed. Top and bottom ventilator control is very important. Several types of bottom ventilators are possible and personal preference may enter into the design. Several authorities recommend the square inlet with a sliding door cover. In designing the bottom ventilator an area equal to the theoretical proves practical, but never build less than this area. Top ridge vents are usually designed about two to six times as large as the theoretical outlet size. For efficiency make it about 2.5 times as large as bottom vent and on two sides so that leeward side can be used to ventilate the barn. Several types can be used but the trap door and the skylight types are not recommended.

Wheat

Nebraska

Same as for "Shelled Corn".

North Carolina

For wheat use farm crop drier or tobacco barn drier as developed by the college, sorghum drier by Texas, rice drier by Louisiana, or metal bins with perforated floor.

U. S. Department of Agriculture

See "Barley". See USDA references Nos. 2, 3, 6.

OPERATING INSTRUCTIONS

Barley

North Carolina

For barley, load bins to proper depth. See AIR REQUIREMENTS. Air gate to bins should be opened fully at the beginning and then closed periodically during drying. See college plans. Follow instructions for other driers as provided by the source of the drier.

U. S. Department of Agriculture

In drying barley with unheated air in warm dry summer weather, moisture content sometimes may be reduced two percent in 24 to 48 hours of operation but usually a longer period will be necessary. Drying is more rapid during the day than at night. The fan may well be started at 9 or 10 A. M. on clear days and operated until 7 to 9 P. M. With heated air continued ventilation after the heater is shut off will cool the grain and partially equalize the moisture content in the various layers, but the top layers may still be too wet for safe storage. Except for short time storage it will be desirable to mix the grain by moving it to another bin if it has been dried with a temperature rise of more than 25 degrees. See USDA references Nos. 2, 3, 6.

Beans

Washington

In college tests beans were dried in one cubic foot lots.

Broomcorn

Texas

Not more than five trays of broomcorn should be dried at one time. The depth of the broomcorn on each tray should not exceed six inches.

Corn

Georgia

For seed corn it is better to overdry, as fairly dry seed will often pick up moisture during damp weather. See MOISTURE REQUIREMENTS. By reversing the direction of air flow more uniform drying will result. See AIR REQUIREMENTS.

Illinois

For ear and shelled corn see USDA recommendations.

Indiana

ESTIMATED FUEL REQUIRED TO DRY 1,000 BUSHELS OF EAR CORN TO AN AVERAGE MOISTURE CONTENE OF 12 PERCENT

Initial Kernel Moisture Content (Wet Basis) (Percent)	Water to be Removed per 1,000 Bushels (Gallons)	Fuel Consumption* to dry 1,000 Bushels (Direct Heat) (Gallons)	Storage Space Occupied by Initial Corn (Cubic Feet per Bu.)
30	2,750	460	3.13
28	2,375	400	3.04
26	2,040	340	2.93
24	1,705	285	2.84
22	1,392	235	2.76
20	1,080	180	2.69

* Fuel estimate based on: 5 to 10 cfm per bu; 2,620 Btu to remove one lb. of moisture; direct heat dried, if heat exchanger multiply by 1.41; heat output, 120,000 Btu per gal. of fuel.

When the amount of fuel shown in the previous table has been consumed, begin to take samples to see if the crop is dry. When sampling take kernels from at least 10 ears, six inches to one foot from surface where air leaves corn. Costs for fuel and electricity average 3 to 10 cents per bu. Average total cost of drying is 10 to 12 cents per bu. With unheated air, operate the fan when air temperature is above 50 F and relative humidity is below 70 percent. In mild weather operation it may be necessary to operate the fan to prevent heating of corn. With good weather, corn can be dried with forced air in fall and early winter after which natural ventilation will be sufficient. For shelled corn see USDA recommendations.

Iowa

For ear corn intermittent operation of the heater, on half of the time and off half, will give about the same fuel economy and the same drying results as continuous operation at half the fuel rate provided the heater will work efficiently at the half rate. If the heater works better at full rate a gain in efficiency may be expected. The on and off periods may be anywhere from on 15 minutes, off 15 minutes to on four hours, off four hours, or perhaps even longer periods. The short period of heater operation will be desirable if a longer period would raise the temperature above a desired limit, say 130 F. For shelled corn see USDA recommendations.

Kentucky

Distribute ear corn evenly in the crib. Place highest moisture corn over floor two to three feet deep during first part of harvest season. Operate the fan only when weather is favorable. Temperature should be above 50 F. Good results will occur at 65 percent relative humidity and lower. It may be necessary to operate fan if corn moisture content rises above 18 percent

Kentucky (Cont)

especially in early spring. Tests to determine moisture content of corn should be made if at all possible. Mills, elevators and most hybrid seed corn growers have testers. A field sample should consist of at least 20 ears taken from all parts of field. Remove two rows of kernels from each ear. Seal in a mason jar until test can be made.

Michigan

For ear and shelled corn see USDA recommendations.

Nebraska

Ear corn can be dried by forcing air through the corn from the botton with sides and ends of bin air tight and depths up to eight feet. For shelled corn, depths of four to six feet are usually recommended for economical drying. Start the fan as soon as grain is spread over bin floor at a uniform depth. A good practice is to finish drying with air as cool and dry as possible, and operating at night if weather is right. During storage cool dry air can be forced through at intervals but not unless the relative humidity is below 50 percent and air temperature below that of the grain.

North Carolina

For ear and shelled corn see "Barley".

Ohio

Ear corn should be husked clean before storage. Silks and shelled corn should be removed or at least distributed evenly in crib to prevent concentration that reduces ventilation. Corn at a depth of 10 ft. has been dried successfully. In one instance the fan was operated about three weeks to dry the corn from 33 to 18 percent moisture. In cool rainy weather operate the fan often to keep the corn cool and run continuously regardless of weather if the moisture content is above 28 percent, unless the corn is frozen. Shelled corn should not be placed over seven feet deep. Shallower depths of one to two feet are better. If hay mow drier is to be used a maximum depth of two feet is recommended. Ventilation should be continuous during warm sunny days and cool nights. When once chilled in a tight bin corn stays cool for long periods during fall, winter and spring.

Oregon

For shelled corn fill the columns and hopper. Do not start the draw-off rolls until the corn in the column is dry. Moisture testing equipment should be acquired. Adjust the rate at which corn is removed until corn at 15 percent moisture content is obtained. The drier can be stopped for short periods and, on resuming operations, be allowed to warm up before the draw-off rolls are started. At first the air intake should be opened wider than under normal operating conditions.

U. S. Department of Agriculture

With unheated air, ventilation of ear and shelled corn should begin as soon as crib is full. Operate the fan continuously except in rain of fog. Automatic control may be used but it is questionable as to whether it will pay for the equipment needed. If intermittent ventilation is used start fan at 10 A. M. except on rainy or foggy days and run until about 10 P. M. Drying with heated air can be carried on through any kind of weather.

Wisconsin

For ear corn, if dried in a bin or crib with tight sides recommend a depth of 10 to 20 ft.

Cottonseed

Texas

In college tests linted cottonseed was aerated at a depth of eight feet and unlinted at a depth of four feet.

Cowpeas

Texas

In college tests with cowpeas a single layer of sacks was placed on the drier.

Flax

Texas

Recommend a column type drier for flax with each column 10 in. thick, 6 ft. high and 9 ft. long.

Grain Sorghum

North Carolina

See "Barley".

Texas

In college tests with grain sorghum a batch type column drier was used with automatic controls to eliminate possible fire hazards caused by fan stoppage or flame failure. Automatic controls also were used on sub-floor driers.

U. S. Department of Agriculture

See "Barley", also USDA references Nos. 2, 3, 6, 8.

Grain

Nebraska

The practical limits on grain depths for forced air drying are about eight feet. See corn.

Hay

California

Hay at 50 percent moisture content or below should be loaded during periods of high humidity to prevent leaf shattering. Spread long or chopped hay evenly over entire system. Stagger the layers of baled hay so that cracks are covered. When long or chopped hay reaches a depth of two feet over ducts the blower should be started. Continuous operation is required for baled or chopped hay. Long hay may be dried by either continuous or intermittent blowing. Many prefer the continuous operation as mold and bacterial action are kept at a minimum. Hay has been known to heat at night if blower is stopped. To prevent spoilage with intermittent operation the blower should be operated one hour out of every four or five. This may be regulated with a timer. Automatic control by thermostat or humidistat is not recommended. When hay appears dry the blower may be stopped for one or two days; then start and inspect the hay for warm air or steam. If any is found continue blowing for two days and repeat the test.

Connecticut

Provide a means of checking the static pressure in the system. Continuous operation during filling and three days thereafter is recommended. Following an "on and off" tapering period, an overnight "off" period will usually show whether further operation is required as heat will be driven out when fan is started. Vertical formers may be used by placing them on the floor when starting to fill the mow with hay. After a depth of nearly four feet is reached they should be lifted about three feet. Continue this operation until a depth of about 18 feet is reached, then remove formers from the hay. For long hay the depth in the mow may be increased as rapidly as hay can be placed with minimum packing. Keep the surface level. Tramp to prevent chimneying at posts and along walls. For chopped hay recommend first filling up to eight feet and then add three to four foot depths at three-day intervals. The longest cut possible with the chopping equipment available is desirable. Do not pack the hay and avoid walking on it as little as possible. For baled hay stagger alternate layers to eliminate chimneys. First filling may be up to eight bales high. May add

Connecticut (Cont)

three or four bale depths at three-day intervals. Provide two inch space around bottom bales to allow for compression.

Illinois

In tests with alfalfa hay the blower was automatically controlled to operate at 105 F or when relative humidity of outside air was low enough to afford suitable drying conditions. There was no tendency for the hay to reach dangerously high temperatures when the blower was set to operate automatically. If blower operation is not automatically controlled it should be operated continuously for the first three days and nights after the hay is stored.

Indiana

Cut hay at proper stage of growth and watch weather forecasts closely. Gather just before shattering occurs unless weather threatens. For chopped hay cut as long as possible, four to six inches is preferred. Distribute hay evenly and walk on surface as little as possible. For baled hay use minimum tension on wire. Place bales close together in mow and lay adjacent layers at right angles to each other. Store only half that recommended in the table showing suggested rates of storage. Depth can be the same but use only one half the floor area because of greater weight. Start fan as soon as system is covered and operate continuously until hay is dry. This can be determined by overnight shutdown and then start fan in morning and check for warm air coming from hay.

SUGGESTED RATES OF STORING CHOPPED OR LONG HAY (35 PERCENT MOISTURE) IN VARIOUS SIZE MOWS USING FANS POWERED BY 5 HP AND 7½ HP MOTORS *

Mow Floor Dimensions	HP of Fan or Blower	Depth First Week (Feet)	Add Second Week (Feet)	Add Third Week (Feet)
For Slatted Floor Systems				
30 x 30	5 hp	10	8	0
	7.5 hp	12	6	0
36 x 40	5 hp	8	7	3
	7.5 hp	10	8	0
36 x 50	5 hp	7	7	4
	7.5 hp	9	8	1
40 x 50	5 hp	7	6	5
	7.5 hp	9	8	1
40 x 60	5 hp	6	5	5
	7.5 hp	8	7	2

Indiana (Cont)

Mow Floor Dimensions	HP of Fan or Blower	Depth First Week (Feet)	Add Second Week (Feet)	Add Third Week (Feet)
For Triangular and Rectangular Systems				
36 x 30	5 hp	12	--	
	7.5 hp	12	--	
36 x 40	5 hp	10	2	
	7.5 hp	12	--	
36 x 50	5 hp	8	4	
	7.5 hp	10	2	
40 x 50	5 hp	8	4	
	7.5 hp	10	2	
40 x 60	5 hp	7	5	
	7.5 hp	9	3	

* This table indicates that a mow 36 x 50 ft. equipped with a five hp unit should have no more than a seven foot thickness of wet hay (chopped or long) the first week; an additional thickness of seven feet the second week. The second week's quantity of hay should be loaded over the center main duct in a rounded manner. Additional four feet of hay can be placed on top of the hay after the first two loadings are dry.

Kentucky

Usually the hay must be uniformly distributed. Most systems are designed so that the first hay put on the drier should not exceed a certain depth. With a drier of proper design hay can be cured in batches to a height of 20 ft. Fan should be started as soon as first hay is in drier. The fan is operated continuously until the hay is dry. This may require from one to two weeks. Operate until hay 12 inches below top seems dry; then stop fan and immediately walk over hay and try to find warm spots. If none can be found, leave fan off for a few hours, and then start. If the air from the hay is warm the fan should be operated longer. Repeat test as often as necessary until no heat can be found coming from the hay or as often as desired to make sure hay is keeping safely.

Maine

For hay drying provide a means of checking the static pressure in the system. Continuous operation during filling and three days thereafter is recommended. Following an "on and off" tapering period, an overnight "off" period will usually show whether further operation is required if heat is driven out when fan is again started. This check should be made every second or third day for at least two weeks after tapering off period

Maine (Cont)

has been completed. For long hay the depth may increase as rapidly as the hay can be placed with minimum packing. Keep the surface level. Tramp to prevent chimneying at posts and along walls. For chopped hay the first filling should not exceed eight feet. Add three to four foot depths at three-day intervals. Use longest cut possible. Do not pack the hay and walk on it as little as possible. A shallow layer of long hay over the duct work is desirable. For baled hay stagger alternate layers to eliminate chimneys. First filling may be up to eight bales high. Add three or four bale depths at three-day intervals. Provide two inch space around bottom bales to allow for compression.

Michigan

Hay may be placed in the mow continuously at a rate of five feet per day of long hay, three feet of chopped hay and two layers of baled hay. Operate the fan continuously for first few day, even during showers. Leave hay doors and windows open. Chopped hay should be cut a minimum length of two inches, preferably three inches. Maximum depths are 15 ft. for long hay and 12 ft. for chopped hay when using a side main duct. With a high center main duct equipped with top and bottom doors the depth may be increased to 20 ft. or more depending on barn width. Six to seven bales deep is maximum for drying loosely baled hay. Avoid packing the hay except around posts, braces or along edges of mow. For shallow depth systems keep the hay level and for deep storage systems pile the hay higher over the main duct. Areas in which the hay is drying faster can be restricted to flow of air so that wetter areas dry faster. When the hay is nearly dry at the top the fan does not need to operate continuously, possibly only during afternoon and evening. Check the hay for heating every two to three days for a week or more by walking on it after the fan has been started. Humidistat and time clock controls are not needed.

New Hampshire

See "Maine". Depths of long hay up to 26 feet have been reported.

North Carolina

Load hay to proper depth. See AIR REQUIREMENTS. See college plans for farm crop drier.

Ohio

For 45 percent moisture hay a maximum depth of six feet is recommended until this is dry. Hay has been stacked to a total depth of 15 feet at the University. The fan can usually operate all the time. In rainy weather operate for an hour or two every 6 to 12 hrs. or long enough to cool the hay. Operate the fan regardless of weather when temperature of hay is above that of the air. The fan may be operated at night if it is more convenient. It is advisable to operate the fan a few hours for about

Ohio (Cont)

two days after the top of the hay feels dry. Inspect for hot spots while fan is operating. It is desirable to have thermometers to take the temperature at the fan and above the hay. Some method of determining the humidity is also desirable. Automatic devices for starting and stopping are usually not necessary. For baled hay good drying starts with uniform baling and fairly uniform moisture in the bales in one tier. Once in the mow it becomes a matter of supplying ample air at all times. For long hay the fan may advantageously be operated continuously at times. It might be advisable to operate the fan on nights when the air is cool, and stop during warm humid days. The best drying with natural air is likely to take place when the air is cooler than the hay. Chopped hay should be cut in lengths of four to six inches. Dry in layers of three to four feet in depth. If it is nearly dry, greater depths may be used.

Oregon

Mow only enough hay at one time to fill drier. For long hay, load to maximum of 10 ft. deep and distribute evenly. For chopped hay load the drier not over six feet. Chop hay as long as possible, not less than two inch cut. Do not tramp on chopped hay when loading drier.With a no heat type drier operate fan continuously for first 48 hrs. After that operate when air is below 75 percent humidity. Off periods should not exceed six hours. When the top foot of hay is dry the rest is usually dry except for possible packed spots which require fan operation until heating stops. For second load of long hay do not exceed a depth of five feet.

Pennsylvania

Cover drier uniformly with hay. Start fan and operate continuously until nearly dry. Where filling is slow cover main duct first then level off and add more hay. Avoid packing. If possible use a blower and distributor pipe. When hay appears dry turn off fan for six hours, then while standing on hay have fan turned on. If heat is expelled continue drying and repeat this test every day until no heating occurs.

Tennessee Valley Authority

It is extremely important that the hay be evenly spread over the duct system. The total depth of any one batch of hay should not exceed eight feet, and for best efficiency not less than four feet. The total depth of settled hay should not exceed 15 to 16 ft. The fan should be started as soon as the first hay is placed in the mow and operate continusouly until the top layer is partially dry. May operate intermittently after that if desired. In general hay should not heat above 110 F and any time the hay temperature is 15 to 20 degrees above outside air the fan can be operated to advantage regardless of weather conditions. After five or six days of operation check the hay at a depth of 1 to $1\frac{1}{2}$ ft. If the hay appears to be dry enough the fan operation can be stopped. To be sure the entire mass is dry operate the fan 20 to 30 min. for three or four days more. With the blower running,

Tennessee Valley Authority (Cont)

walk over the hay and if warm air is felt rising from any spot in the hay, the hay is not dry and the blower should be operated another day or two. See AIR REQUIREMENTS.

Texas

For alfalfa hay the pre-drying period varies with weather and type of hay but for most areas recommend field drying to at least 50 percent moisture. Coarser hay such as sweet sudan, may require several days to reach 60 percent and in an emergency it may be necessary to place it in the drier at a higher moisture content. In college tests with baled hay, bales were placed on edge and stacked three to six bales high. Different methods of stacking were used for the tests. For chopped hay the length of cut should average at least four to six inches. Using the farm type trailer it was found that the hay could be stacked about four-fifths as high as the distance from the side of the duct to the outside of the trailer.

U. S. Department of Agriculture

Distribute hay evenly over drying system. The first hay should not be less than four nor more than eight feet deep. After this has dried, hay can be added in depths not greater than six feet. Do not exceed maximum depth for which system was designed. Operate fan continuously. Fan should be operated on an intermittent schedule during the night and periods of bad weather after the first five or six days running for about one hour out of four to six hours. When top two feet appear to be dry shut fan off for 12 hrs. then start fan and determine if any warm air is coming out of hay. If no warm air is felt shut fan off for 24 hrs. and repeat test. If no warm air is felt the hay is ready for storage. See USDA reference No. 10.

Vermont

See "Maine".

Virginia

Cut alfalfa hay in morning after dew is off but no more than can be put in late the same day, or cut late in afternoon, but no more than can be put in the next day. Spread hay evenly over the duct system and not less than four feet or more than eight feet deep for first loading. Additional loadings, of up to six foot depths after first loading has dried, can be added until total depth reaches approximately 15 ft. Start the fan within two hours after first load of hay is on drier and run continuously for four to six days. After that operate from 8:00 a. m. to 9:00 p. m. except when raining. On foggy or rainy days operate one hours out of four. During night regardless of weather, run as follows:

OFF	ON
9:00 p. m. to 12:00 Midnight	12:00 Midnight to 1:00 a. m.
1:00 a. m. to 4:00 a. m.	4:00 a. m. to 5:00 a. m.
5:00 a. m. to 8:00 a. m.	

Virginia (Cont)

When top foot of hay seems dry, stop the fan overnight. In morning start the fan and walk on hay observing if any heat is coming out. If so, operate for two days and repeat the test.

Washington

In college tests with beet top hay the drier was loaded to a depth of 18 in. Pea vines placed in the drier to a depth of one foot gave good results. This test was repeated for 2 and $2\frac{1}{2}$ ft. depths with equally good results. When the pilot plant was loaded to a depth of four feet, however, on the fifth day after loading, the vines turned moldy and matted together. This test was repeated at a depth of $3\frac{1}{2}$ ft. and on the fifth day the vines again turned moldy. The test was repeated with similar results. From these tests it was concluded that time was the important factor and not the depth of loading. The vines must be dried in five days or they will mold even when cool. If not kept cool they will heat and mold in 24 to 30 hrs. Once they start to mold they mat and stick together and it is practically impossible to blow air through them. The test was repeated using a depth of vines of one foot and the air was reduced to four cfm per square foot. The vines were cool throughout the test but on the fifth day they turned slimy and moldy. This lead to the conclusion that the depth of loading should be governed by the drying rate. The vines should be dried in four days.

Wisconsin

Recommend that hay be chopped with a theoretical length of cut not less than two inches and preferably three inches if possible. The actual length will be about twice the theoretical. Not more than four to six feet of damp hay should be placed in the barn in one layer and consider the compacting of the first layer when the depth of second is determined. It is not practical to dry hay at a total depth of more than 16 ft. and when this depth is approached the layer of damp hay should not be greater than four feet. Avoid tramping on the hay and spread evenly over the drier. The door provided on top of main duct should be opened after hay is four to five feet above the top of main duct. The small doors to the slatted floor can be closed as additional hay is added in the mow. Fan should be started as soon as hay is placed in the mow and run continuously until dry areas appear on top of the hay. Then the fan may be stopped and run one hour out of four or five until all the hay is dry.

Oats

North Carolina

See "Barley".

U. S. Department of Agriculture

See "Barley", also USDA references Nos. 2, 3, 6.

Peanuts

Georgia

Peanuts should be spread out uniformly over a perforated floor rather than dried in the bag. Can be dried to depth up to eight feet. Reversing the air flow gives more uniform drying above three foot depths.

North Carolina

Peanuts for oil stock, can be dried in 24 hrs. or less if air requirements are met and intake air temperature is 100 to 105 F for first 12 hrs; 110 to 115 F for next nine hours; and 120 F for last three hours. Intermittent drying having a five hour drying period with a 19 hr. rest period reduces the drying time.

Oklahoma

Peanuts were sacked immediately after threshing and placed in drier. Usual practice was to place the sacks two layers deep, with the second or top layer covering three or four inch openings left between the bottom sacks.

Texas

In college tests peanuts in sacks were stacked around the tunnel in such a way that the distance that the air travels is about the same in all directions. They were also dried by means of a column type drier.

Potatoes

North Carolina

Cure sweet potatoes in crates or baskets at 85 F for 7 to 10 days then drop temperature slowly, in two or three cays, and hold between 50 and 55 F until marketed. Ventilate only enough to prevent excessive accumulation of moisture.

South Carolina

For sweet potatoes maintain the desired temperature and humidity conditions. See MOISTURE and HEAT REQUIREMENTS.

U. S. Department of Agriculture

For white potatoes operate so as to maintain proper conditions of temperature, air circulation and humidity. See USDA reference No. 7.

Rice

Arkansas

Adequate cleaning equipment is very important in rice drying. Foreign matter of high moisture content is difficult to dry and is frequently responsible

Arkansas (Cont)

for choking the elevating and conveying equipment. Heating and mold growth have been known to occur first in this foreign matter.

California

For best results do not reduce moisture content of rice by more than three percent in any one drying operation. This requires a tempering period of 12 to 24 hrs. in bulk bins and careful attention. Tempering for more than 48 hrs. is dangerous because of possible heat damage. Sack driers are not as easily operated because of sack handling and may also result in lack of uniformity in drying.

Texas

Rice was dried in college tests by using a tunnel type drier which has a one quarter inch steel top as the floor. Openings, 13 by 26 in., were made in the steel floor and one sack of rice is placed over each opening for drying. The tunnel is divided into two parts so that all or only one half can be used at one time. It can be operated in smaller sections by means of removable partitions in the tunnel.

Rye

U. S. Department of Agriculture

See "Barley", also USDA references Nos. 2, 3, 6.

Seeds

Georgia

Seeds may be piled loose or bagged depending on type of floor. If loose level off to uniform depth to insure even air flow. If bagged, pile the bags close together and fill cracks or openings with empty bags to prevent excessive air loss. In the Texas type drier, loose seed is contained in screened, vertical columns and the air is blown outward through the seed.

North Carolina

For lespedeza seed and seed cotton see "Barley".

Texas

In college tests with Dallis grass seed the sacks were filled two-thirds full so they fit closer together and offer less resistance to air flow. Two layers were dried, the top one placed so as to cover spaces between

Texas (Cont)

the first layer. Other openings and side wall space was stuffed with burlap bags. For Rescue grass seed a column-type drier with several minor changes was used.

Soybeans

North Carolina

See "Barley".

U. S. Department of Agriculture

See "Barley", also USDA references Nos. 2, 3, 6.

Sugar Beets

Colorado

Do not allow dirt, trash or leaves to accumulate under the piler discharge as this prevents air circulation and presents an opportunity for hot spots to form. Dirt elimination and a continuous oscillating boom would help to overcome this problem.

Michigan

Trash deposits limit air flow and cause excessive beet respiration. Trash and dirt must be kept at a minimum in the piles.

Tobacco

North Carolina

Bright leaf tobacco curing is essentially a job of maintaining proper temperature--humidity ranges and accurate timing of each operation. Timing is a skill developed by experience and is always a matter of judgment based on the appearance and conditions of the majority of the tobacco in the barn. Poor judgment can result in undesirable conditions such as "sweating" which may occur at 110 to 150 F due to insufficient ventilation, improper spacing, crowding, or too rapid a rise in temperature. Also, "sponging" may result if the temperature and humidity are not adjusted to 103 F and 75 percent respectively soon enough during the cure. See AIR and MOISTURE REQUIREMENTS.

Wheat

Nebraska

The practical limits on grain depths for forced air drying are about eight feet. See "Corn".

North Carolina

See "Barley"

U. S. Department of Agriculture

See "Barley", also USDA references Nos. 2, 3, 6.

Barley

U. S. Department of Agriculture

The quality of barley is affected adversely by improper conditioning and storage. Losses through insect attacks are due chiefly to inadequate storage structures, improper conditioning, failure to clean and spray gins and remove old grain, inadequate inspection and failure to fumigate efficiently or at proper time. See USDA references Nos. 2, 3, 6.

Beans

Washington

Germination of beans was not affected by drying. The percentage of cracked beans was increased by the drying operation.

Broomcorn

Texas

Artificially dried broomcorn had deep uniform green color. There was no indication of damage to the fiber and no appearance of overdrying in any of the layers.

Corn

Georgia

Moisture differential is not important if the farmer is going to feed the corn but it is important to him if he sells it for seed.

Illinois

For ear and shelled corn see USDA recommendations.

Iowa

Ear corn losses are measurable only when there is damage to the corn in the cribs due to mold growth or rodents.

Kentucky

With mechanical drying, ear corn can be increased in grade from Sample to at least Number 2.

Michigan

For ear and shelled corn see USDA recommendations.

Nebraska

A definite indication unfavorable to the higher drying temperatures was found in the commercial grading of shelled corn. Results also indicate that certain temperatures reduce the feeding value of the corn protein.

Ohio

Germination of ear corn may be damaged by temperatures higher than 110 F.

U. S. Department of Agriculture

In drying tests with ear corn in Iowa, Illinois, Indiana, Ohio and Michigan 1947-48, severe mold damage would have occurred in nearly all cribs if the corn had been held in storage all summer without drying. See USDA references Nos. 1, 2, 3, 4, 5, 6, 8, 9, 11.

Flax

Texas

Artificial drying with air temperatures of 125 to 175 F had no detrimental effect on the oil content of flax dried from 11 to 15 percent moisture to 7 percent.

Grain Sorghum

Texas

There is little danger of impairing wet-milling characteristics of Martin or Early Hegari by artificial drying at recommended temperatures and moisture content. Damage to Martin seems to be related to moisture content when harvested and the extent of the drying. Samples of artificially dried Martin were harder after steeping than naturally dried Martin, and required more power for grinding.

U. S. Department of Agriculture

See "Barley", also USDA references Nos. 2, 3, 6, 8.

Hay

California

See USDA recommendations.

Connecticut

Good hay is a feed hard to replace and cows should receive at least one feeding of five to six pounds per day when they are getting all the grass silage they will eat. Grass silage can totally replace corn silage and hay. However, from a cropping standpoint it is not practical on most farms. Properly handled barn dried hay has higher feeding quality than field cured hay.

Illinois

In virtually all cases loft-cured alfalfa or soybean hay was judged to be of better quality than similar field-cured hay.

Indiana

Tests indicate that hay dried with supplemental heat contains a higher percentage of carotene than ordinary mow cured or field-cured hay.

Kentucky

FIELD CURING VS. BARN CURING

Field cured	Barn cured
1. $\frac{1}{4}$ to $\frac{1}{2}$ of the leaves left in the field.	1. No leaves left in the field.
2. Rain damage 3 times out of 5. Losses may be up to 67% of minerals, 35 % of carbohydrates and 18% of proteins.	2. No losses.
3. Sunlight and high temperatures can destroy up to 80% of Vitamin A (carotene).	3. Loss of Vitamin A does not amount to much.
4. Mow sweating or heating reduces carotene (Vitamin A) and digestibility of proteins.	4. Can be cured without mow sweating or heating.
5. Sheep will waste from 1/10 to 1/4 of their hay; other stock in smaller portions, due mostly to mustiness.	5. Barn cured hay reduces feeding wastage. It is free of mold and more palatable.

Maine

Properly handled barn hay has more feeding quality than field cured hay.

Michigan

Fewer soluble nutrients are lost in barn drying of hay. Fewer leaves and small stems are lost and this saving increases the amount of dry hay harvested by 10 to 15 percent. Hay has a better physical condition, better color and less dust. Due to earlier cutting some of the hay will have a higher feeding value for dairy cows because it is less mature.

New Hampshire

Properly handled barn cured hay has more feeding quality than field cured hay. Possible exception: field cured hay handled with exceptional care and laboratory precision.

North Carolina

In college tests with articially dried baled hay the quality of dried hay ranged from sample grade musty and moldy to U. S. No. 1. Samples for analysis showed from 2.47 to 3.07 percent nitrogen and from 15.44 to 19.19 percent crude protein. The feeding **value of artificially dried peanut hay** was equal to field cured control hay in college tests. The big saving through artificial drying was the more pounds of hay that was lost through leaf shattering and leaching in the control hay. Peanut hay always had an excessive amount of dirt which caused a dry cough in two yearlings, and added discomfort to mow handling.

Ohio

It is a fair estimate that, on the average, one half of the first cutting of alfalfa hay is lost as feed. Leaf shattering is one great loss, as the leaves carry 60 to 75 percent of the total protein in the hay. In addition vitamins and other food values are reduced greatly by weathering. Extra good quality hay with practically no loss of leaves or color can be obtained by barn drying if cutting and curing time is planned carefully.

Oregon

Feed ensiled at an early stage of growth has a high protein content so that it may cut down the hay requirement for feeding by 50 to 75 percent. The carotene content of grass and legumes is more fully preserved when harvested as silage. Grass and legume silage is palatable and is the best substitute for excellent, well-managed pasture. Many weeds do not mature and scatter if cut for silage and weeds not strongly flavored are more palatable as silage than as cured hay. Experiments show that immature grasses or legumes when ensiled produce more butterfat per acre than when made into hay, even if drying conditions are perfect.

Pennsylvania

High quality hay is one of the cheapest and best winter feeds. Barn drying will save leaves, green color, nutrients and sometimes prevent entire loss of crop.

Tennessee Valley Authority

Field curing losses for hay may amount to as much as 25 percent or entire loss of crop depending on weather conditions.

Tennessee Valley Authority (Cont)

EFFECT OF HAY DRIER ON HAY QUALITY

	Grade Requirements for Alfalfa			
	U. S. No. 1 (Percent)	U. S. No. 2 (Percent)	U. S. No. 3 (Percent)	U. S. Sample (Percent)
Percent leaves	40 or more	25 or more	Less than 25	Hay which contains more than 15 percent foreign material or which is otherwise of distinctly low quality
Percent green color	60 or more	35 or more	Less than 35	
Maximum percent foreign material	5	10	15	
Barn cured	54	34	7	5
Field cured	9	26	35	30

COMPARATIVE ANALYSIS OF BARN CURED AND FIELD CURED HAY*

	Leaves (Percent)	Green Color (Percent)	Carotene (ppm)	Protein (Percent)
Barn cured	43.6	63.8	40.0	18.1
Field cured	34.7	46.2	20.9	15.0

* Based on analyses by Dr. L. A. Moore, University of Maryland, Tennessee State Department of Agriculture and USDA.

Texas

Artificial drying produces a better quality of alfalfa hay with higher protein and vitamin content. In college tests a fifth cutting of alfalfa, dehydrated before it began to bloom, contained 276 ppm of carotene. The same hay after two days of sun curing contained 42 ppm of carotene. In other tests, artificially dried hay was 2.5 times higher in carotene and higher in protein than hay which received normal field curing. Most growers prefer to save peanut hay for livestock feed and use winter cover crops to provide organic matter for the soil.

U. S. Department of Agriculture

Protein losses of hay during harvesting occur along with dry matter, mainly through the loss of the whole plant, particularly the leaves, and from leaching. Carotene losses take place rapidly during harvesting and storage. The longer the hay is exposed to the sun the greater the loss of carotene. This loss also occurs during mow drying and in the silo.

U. S. Department of Agriculture (Cont)

GRADING COMPARISON SIX MONTHS AFTER HARVESTING

	Green Color Percent	Leaves Percent	Grade
Mow Dried Hay	56	50	No. 2 Extra leafy Alfalfa-Clover mixed
Field Dried Hay	54	36	No. 2 Alfalfa-Clover mixed
Silage		50	Excellent, good aroma and high palatability

DRY MATTER LOSSES DURING HARVESTING AND STORAGE

	Dry Matter Content in Hay		
Time	Mow-Dried Percent	Field-Dried Percent	Silage Percent
When cut---	100	100	100
Stored-----	87	83	94
Fed--------	79	79	84

PROTEIN LOSSES DURING HARVESTING AND STORAGE

	Protein Content in Hay		
Time	Mow-Dried Percent	Field-Dried Percent	Silage Percent
When cut---	100	100	100
Stored-----	84	71	91
Fed--------	74	70	87

CAROTENE CONTENT DURING HARVESTING AND STORAGE

	Carotene per Gram of Dry Matter		
Time	Mow-Dried Micrograms	Field-Dried Micrograms	Silage Micrograms
When cut---	308	297	304
Stored-----	122	49	217
Dried------	29		
Fed--------	22	21	80

Feeding trials showed the relative milk production per acre of hay harvested to be eight percent more for mow dried hay and 12 percent more from silage than for field-dried hay. See USDA reference No. 10.

Vermont

Properly handled barn cured hay has more feeding quality than field cured hay.

Virginia

It has been estimated that at least 25 percent of the feeding value of the hay crop is lost each year due to bad weather at harvest time. Reports show that the protein content of barn dried alfalfa hay ranged from 18 to 24 percent, and often twice as much as field cured hay if damaged by weather. Samples graded by USDA have shown mow-dried hay to be one to two grades better than field-dried hay.

EFFECT OF HAY-DRIER ON HAY QUALITY

	U. S. No. 1 High Feeding Value	U. S. No. 2 Fair Feeding Value	U. S. No. 3 Poor Feeding Value	U. S. Sample Very Poor Feeding Value
	(Percent)	(Percent)	(Percent)	(Percent)
Barn Cured	49	42	3	6
Field Cured	None	19	25	56

Washington

Beet top hay contained the following feeding value when dry:

Sample	Protein (Percent)	Carotene (ppm)
1	9.1	26.0
2	9.2	31.0
3	9.4	35.0

No off flavor was noted in the milk produced by cows fed beet top hay at a rate of 15 lbs. per day for one week. Pea vine hay contained the following feeding value when dried with unheated air.

Sample	Crude Protein (Percent)	Carotene (ppm)
Pea Vines	13.0	30.0

Wisconsin

Long cut is desirable for chopped hay as it will dry easier and be utilized better by dairy cows. Barn drying will allow the crop to be stored while it is still tough. This greatly reduces the loss of leaves which are the most valuable part of the crop, especially with the legumes.

Oats

U. S. Department of Agriculture

See "Barley", also USDA references Nos. 2, 3, 6.

Peanuts

Alabama

There is no change in free fatty acids in peanuts due to artificial drying with 40 percent moisture when recommended procedure is followed.

Georgia

Peanuts can be dried mechanically at an economical rate and the quality is not adversely affected. No specific values have been determined.

North Carolina

Artificially dried edible peanuts showed greater tendency to splitting and skin slippage. Physical appearance was superior to field dried and produced a product fully as good as field dried nuts. Germination was good. It has not been demonstrated that the quality of artificially dried peanuts is any better than the quality of field dried peanuts.

Oklahoma

Germination, based on a sample of peanuts, which were batch dried from 18 down to 6.6 percent in 10 hrs. was 97.3 percent.

Texas

There was no indication of serious damage to peanuts field dried for at least two or three days and then artificially dried with an air temperature of 125 F that would make them undesirable for crushing purposes. They can be dried artificially at this temperature without a detrimental effect on germination. In some cases, there was a disagreeable flavor noticed in peanuts threshed green and dried immediately with artificial heat. Further research is necessary.

Potatoes

South Carolina

For sweet potatoes, the wounds caused during harvesting and handling are best healed at a high temperature and humidity. Wide fluctuations in temperature induce undue shrinking and rotting of the roots.

U. S. Department of Agriculture

The grower often has no measure for estimating losses in weight and quality from poor storage of white potatoes. Sound and disease-free potatoes may be held in any type storage for two or three months with little noticeable loss or damage for longer periods the value of proper storage increases rapidly. The keeping quality is also affected by injuries or diseases occurring before storage begins. See USDA reference No. 7.

Rice

California

The quality of rough rice when dried in sacks may be inferior to rice dried in bulk driers.

Texas

Rice can be artificially dried without detrimental effect on germination and have high milling yields when properly dried. See HEAT REQUIREMENTS.

Rye

U. S. Department of Agriculture

See "Barley", also USDA references Nos. 2, 3, 6.

Seeds

Georgia

Long drying periods often affect seed viability greatly.

Tennessee Valley Authority

In tests, a sample of crimson clover seed, not dried but sacked and stored for several weeks, showed definite signs of mold. The germination was 58.1 percent. A corresponding sample, dried on the drier showed a germination of 82.5 percent.

Texas

Artificially dried Rescue grass seed with an air temperature of 120 F showed 79 percent germination, compared to 89 percent of the air-dried. Results are not conclusive.

Soybeans

U. S. Department of Agriculture

See "Barley", also USDA references Nos. 2, 3, 6.

Sugar Beets

Colorado

Sugar beet sugar losses in the storage pile vary from one fourth to one pound of sugar per ton per day depending on the pile temperature.

Michigan

For sugar beets the storage time is often marked by periods during which the air temperatures do not go below 65 F. Data collected by M. A. Stout and C. A. Fort show that beets stockpiled during such warm periods will lose sugar at the rate of one-quarter to one pound per ton per day depending on the temperature.

Wheat

U. S. Department of Agriculture

See "Barley", also USDA references Nos. 2, 3, 6.

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